THE EFFECTS OF IRRIGATION REGIME AND NITROGEN RATES ON RAPESED YIELD

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ABSTRACT

The paper aims to establish the role of interaction of irrigation regime, and nitrogen rates on rapeseed yield and yield component (number of branches, siliqua number and number of seeds per siliqua). Four Nitrogen (N) fertilizer rates 0 (N_0), 100 (N_{100}), 150 (N_{150}) and 270 (N_{270}) kg/ha, two irrigation regime (non-irrigated (I_0) and irrigated at 50% from IUA (I_1) and one cultivar of winter rapeseed (Dexter) were established. The experiments were conducted in a randomized complete block design arrangement in split factorial with three replicates. Significant positive correlations were established between irrigation regime and nitrogen rates regarding the rapeseed yield and the main morphoproductive characteristics. The achieved results have pointed out that N fertilization and irrigation regime have a positive effect on rape crop. The best results were obtained for I_1 x N_{150}.

INTRODUCTION

As the world reserves of fossil fuels and raw materials are limited, active research interest has been stimulated in nonpetroleum, renewable, and nonpolluting fuels. Biofuels derived from plant sources, appear to be promising future energy sources (http://www.ebb-eu.org/). In this sense, the rapeseed represents one of the most promising resources for biodiesel in Romania.

Rapeseed (*Brassica napus* L.) has some good characteristics such as suitable placement in crop rotation, desirable quality, high value of oil (40 - 45%) and protein (39%) that has changed it to an important crop (Bailey, 1993).

In supporting agricultural production for obtaining high yields, the water and fertilizers play a significant role (Chamorro, 2002, Chauhan, 1993). Water is not the only limiting factor for rape crop. Plants often suffer from nutrient (especially nitrogen, N, phosphorus, P, and sulfur, S, deficiencies, which could be exacerbated by climate and environment changes, especially increased water stress due to the close relationships between water and nutrient availabilities (Clark, 1978, Gan, 2007,). Nitrogen (N) fertilizer plays a crucial role in enhancing rapeseed yield, and because of the great importance of nitrogen for the development of the whole plant, N-deficiency leads very rapidly to reduced and retarded growth and lower yields (Rose, 2008). A high rate of N application increases leaf area development, improves the root system, the number of branches per plant, the number of silique per plant and increases overall crop assimilation, thus contributing to increased seed yield (Bailey, 1993, Rose, 2008).

The present research was undertaken to provide basic information on the response of one winter rapeseed cultivars (Dexter) to irrigation regimes and different nitrogen rates, in order to evaluate the effect of these treatments on rapeseed yield and yield components. The experiments, through differential application of irrigation regime and nitrogen rates, aimed at finding the formula of proper fertilization and irrigation regime with practical recommendations for crop in Transylvania Plain.

MATERIAL and METHODS

A three years experiment was conducted in 2008, 2009 and 2010 at SC COMCEREAL TURDA (46^0 35` N and $23^0$ 47` E, elevation 345 – 493 m above sea level) in Cluj county, Romania. The mean annual precipitation was 657.4 mm in 2008, 471.6 mm in 2009 and 799.3 mm in 2010, during the growing season (October to July). The average of temperature was 10.1 °C in 2008, 9.8 °C in 2009 and 9.8 °C in 2010. Before the experiments, the precursory plant was winter barley. The soil texture was chernozem argiloiluvial vertic with a succession of horizons Am-Bty-C. Ohers characteriscs of the soil: pH 6,5 at the surface (0-15 cm), redox potential, EC,: 1,07 DS/m; humus content: 3,06; phosphorus content, P: 29 ppm; Total nitrogen N: 284 ppm, Organic Carbon: 24,3 g/kg. The experiments have been bifactorial, the summary of the experimental factors, during 2008-2010 are presented in Table 1. Experiments have contained a number of three repetitions (n = 3), the number of variants analyzed in experiment was 12 (4 x 3), the total number of experimental plots was 36 (12 x 3). Experience scheme was realized to ensure the possibility for an uniform allocation and precise measurement of water and has ensured proper isolation of variants in space. Each plot consisted of 2x5 m (10 m^2), spaced 3 m apart.

Table 1 Summary of the experimental factors, Turda, 2008- 2010

Analyzed factors	Graduations
Factor A Irigation regime	I_0 –non-irrigated
	I_1 –irrigated at 50% from IUA
Factor B Fertilization	N_0 –non-fertilized
	N_{100} –fertilized 100 N kg/ha + 75 kg /ha P + 20 kg S
	N_{150} –fertilized 150 N kg/ha + 75 kg /ha P + 20 kg S
	N_{270} –fertilized 270 N kg/ha + 75 kg /ha P + 20 kg S

The base work of the soil was made with the disk harrow, which realized a good mobilization and aeration of the soil without turning the furrow. The sowing was made in the last decade of August with 65 germinal seeds/m^2. The distance between the rows was 18 cm, and the sewing depth was 3 cm. In 2008 there were applied three watering: watering in autumn (emergence and rosette formation): 350 m^3/ha, a watering in the spring (flowering period): 300 m^3/ha, a watering in summer (fructification): 450 m^3/ha (irrigation norm = 1100 m^3/ha). In 2009 there were applied three watering: watering in autumn (emergence and rosette formation): 350 m^3/ha, a watering in the spring (flowering period): 550 m^3/ha, a watering in summer (fructification): 55 m^3/ha, (irrigation norm = 1450 m3/ha). In 2010 there were applied three watering: watering in autumn (emergence and rosette formation): 300 m^3/ha, a watering in the spring (flowering period): 400 m^3/ha, a watering in summer (fructification): 500 m^3/ha. Irrigation norm = 1100 m3/ha. Nitrogen dose was administered in three stages: autumn 25%; spring - 60% (out of winter, on frozen ground); after flowering - 15% (after the appearance of the first internode). Foliar fertilization: FOLICARE 17/9/33 + Bor (Kemira), 5 kg/ha. Phasial fertilization: FOLICUR SOLO (Bayer CropScience), 0.5 l/ha.

At maturity, plants of 1 m^2 in the middle part of each plot were harvested and the numbers of branches per plant, silique per plant, seeds per silique and seeds yield per unit area were recorded. The test were made on variants, the samples were taken from all the three repetitions and were homogenized at the level of every variant. Analysis of variance of the data appropriate to the experimental design and comparison of means at $p \leq 0.05$ were done using POLIFACT software and the means were compared by Duncan Multiple Range Test.

RESULTS

The results recorded are presented in Table 2.

Table 2 The main morphoproductive characters, determined during 2008-2010

Treatments / Experimental variants	Branches (no plants^{-1})	Silique number (no plants^{-1})	Seeds number (no siliqua^{-1})	Seed yield (kg/ha)
2008				
I_0	6.29	99.17	21.08	2282.50
I_1	7.33	115.50	24.75	3067.67
N_0	5.60	83.17	17.83	2066.67
N_{100}	6.47	104.17	22.33	2571.83
N_{150}	7.28	119.17	25.17	2957.50
N_{270}	7.90	122.83	26.33	3104.33
2009				
I_0	4.87	71.42	15.25	1596.75
I_1	5.59	87.00	19.92	2100.17
N_0	4.30	62.17	14.17	1473.50
N_{100}	4.93	73.83	17.00	1793.50
N_{150}	5.43	82.33	18.67	2000.00
N_{270}	5.78	98.50	20.50	2126.83
2010				
I_0	5.56	82.58	16.17	1988.33
I_1	6.73	99.50	20.17	2495.67
N_0	4.92	73.83	14.50	1798.50
N_{100}	5.88	87.67	17.50	2161.50
N_{150}	6.68	98.00	20.00	2466.83
N_{270}	7.10	104.67	20.67	2541.17

Analysis of variance on data showed that effect of year was significant on all agronomic traits. One has been recorded difference among the results obtained during the three years experiment. In 2008, there was sufficient rain over the year with more rain in June improving crop growth, and good drying conditions in July promoting flower pollination. The lower yield of rapeseed in 2009 was attributed to climacteric conditions, especially in June when rapeseed was in its rapid growth phase. The yield increased with the application of watering. Rapeseed grew well in 2010 under conditions of good rainfall.

There was difference in rapeseed yield ant its morphological components between years (Table 2). There are very significant differences between the irrigated and non irrigated variants. The irrigation applied (experimental factor I_1) has been determined the increasing of: ♦yield, with: 785.17 kg/ha (34.4 %) in 2008; 503.42 kg/ha (31.5%) in 2009; 507.33 kg/ha (25.5 %) in 2010; ♦number of branches per plant: 1.18 (21.0 %) in 2008; 0.96 (20.7 %) in 2009; 1.18 (21.0 %) in 2010; ♦number of silique per plant: 16.33 (16.5 %) in 2008; 15.58 (21.8 %) in 2009; 16.92 (20.5 %) in 2010; ♦number of seeds per siliqua: 3.67 (17.4 %) in 2008; 1.18 (21.0 %) in 2009; 4.0 (24.7 %) in 2010.

Similar trends were observed during the three experiments. The yield and its components have increased together with the N doses (Table 2). The N rates applied have determined, comparatively with the variant nonfertilized, the following increases: $\mathbf{N_{100}}$ ♦yield: 505.17 kg/ha. (24.4 %) in 2008; 320.00 kg/ha (21.7%) in 2009; 363.00 (20.2%) in 2010 ♦number of branches per plant: 0.87 (15.5%) in 2008; 0.63 (14.7%) in 2009; 0.97 (19.7%) in 2010; ♦number of silique per plant: 21.00 (25,2) – 2008; 11.67 (18.8%) in 2009; 13.83 (18.7%) in

2010; ♦number of seeds per siliqua: 4.50 (25.2) – 2008; 2.83 (20.0%) in 2009;3.00 (20.7%) in 2010. **N_{150}** ♦yield: 809.83 kg/ha (43.1 %) in 2008; 526.50 kg/ha (35.7%) – 2009; 668.33 (37.2%) in 2010; ♦number of branches per plant: 1.68 (30.1%) in 2008; 1.13 (26.4%) in 2009; 1.77 (35.9%) in 2010 ♦number of silique per plant: 36.0 (43.3) in 2008; 20.17 (32.4 %) in 2009; 24.17 (32.7%); ♦number of seeds per siliqua: 7.33 (41.1%) in 2008; 4.50 (31.8%) in 2009; 5.50 (37.9%) in 2010. **N_{1270}** ♦yield: 1037.67 kg/ha. (50.2 %) in 2008; 653.33 kg/ha (44.3%) in 2009; 742.67 (41.3%) in 2010 ♦number of branches per plant: 2.30 (41.1%) in 2008; 1.48 (34.5%) in 2009; 2.18 (44.4%) in 2010; ♦number of silique per plant: 39.67 (47.7%) in 2008; 36.33 (58.4%) in 2009; 30.83 (41.8%) ♦number of seeds per siliqua: 8.50 (47.7%); 6.33 (44.7%) in 2009; 6.17 (42.5%) in 2010.

According to the date presented on Table 2 the highest values were registered in the fertilization domain N_{150} – N_{270}. Obviously, increase in plant number of branches leads to increase in silique number in plant and seeds on siliqua, like the obtained results in this study (Table 2) In addition, the recorded results demonstrate that it is necessary to irrigate until seed maturity stage.

CONCLUSIONS

- Rapeseed yield was favorable influenced by the nitrogen fertilizers and irrigation that were applied, and which had determined the yield increase once with the increase of the N doses.
- The number of branches per plant varied between the limits 6.29 – 7.90 in 2008, 4.30 – 5.78 in 2009 and 4.92 – 7.10, depending on the treatment applied. The highest values were recorded for N_{150} and N_{270} and I_1.
- Silique number per plant varied in the range 83.17-122.83 in 2008, 62.17-98.50, in 2009 and 73.8-104.6 in 2010. The best values were obtained for the variants N_{150} and N_{270} and I_1.
- The number of seeds/siliqua in the researched domain had an amplitude between 21.8-26.33 in 2008, 14.17 – 20.50 in 2009 and 14.50 – 20.67 in 2010, the highest number being registered on for N_{150} and N_{270} and I_1.
- High nitrogen rates favor the development of rapeseed crop; fertilization at the rate 150 kg/ha has increased the yield and yield components of winter oil seed rape.

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