RESPONSE OF WINTER RAPESEED YIELD TO DIFFERENT DOSES OF FERTILIZER

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Abstract. *Rapeseed culture is a relatively new type of crop in our country. The rapeseed for oil production was reintroduced in Romania in 1995 and until this period, the areas planted with rape were relatively small. At the moment, between 400000 and 500000 ha per year are grown in our country every year, rarely being altogether harvested. The rapeseed on relatively large areas is compromised due to the winter frost. The growth of rapeseed areas in our country is due to some facts such as: the introduction of varieties and hybrids free of erucic acid and glucosinolates, the cultivation of varieties and hybrids resistant to wintering and falling off, the full mechanization of the crops, the high demand of rapeseed on the external and internal market, especially for fuel production. Rapeseed requires a high fertilization being a great nutrients consumer. Fertilizer doses depend on planned yield and soil agrochemical characterization by nitrogen, phosphorus and potassium available content. The research was carried out in Ialomita County during the agricultural year 2016-2017, on a calcic chernozem using Vesuvio hybrid which present good resistance to frost and have a high capacity to regenerate. The experimental scheme was composed from 4 variants (3 replicates), denoted as it follows:* V_1 *– 18-46 DAP 150 kg +* NH_4NO_3 *150 kg;* V_2 *– 18-46 DAP 150 kg +* NH_4NO_3 *200 kg;* V_3 *– 18-46 DAP 200 kg +* NH_4NO_3 *150 kg;* V_4 *– 18-46 DAP 200 kg +* NH_4NO_3 *200 kg. The objectives of the research consisted in evaluation of the influence of mineral fertilization on: rapeseed yield, average height of plant at harvest time, number of lateral branches per plant, number of siliques per plant and on seeds number per silique. The results indicated that application of additional fertilizer doses led to significant yield differences for* V_3 *(110%) and* V_4 *(116%) as against* V_1 *(100%) that was considered as control variant. The other indicators were more or less influenced, depending on the type of fertilization.*

Keywords: *fertilization, hybrid, rapeseed, yield*

INTRODUCTION

Approximately 35 million hectares of rapeseed are grown in the world and nearly one-third of this area is in Europe. The total area has increased over the past ten years by about 10 million hectares especially in North America, but also in Europe and China (BAYER, 2015 Rape Culture Guide).

The increase in the acreage of oilseed species is oriented at diversifying the structure of agricultural crops, primarily by reducing monoculture of cereal crops. This solution may offer numerous benefits, both agronomical and environmental (WAALEN ET AL., 2013). In the cooler part of the temperate climate zone, the winter hardiness of oilseed rape plays an important role (RAPACZ ET AL. 1999). Oilseed rape is gaining an advantage in yield in Central European countries. An important phase for the oilseed yield is the flowering stage, in which the number of siliques per plant is determined. The final number of pods and seeds is determined over a 4 week period and is highly dependent on a continuous supply of assimilates. The number of pods per plant is decisive for seed yield, which ultimately depends on the survival of branches, buds, flowers, and young pods, and not the potential number of flowers and pods (DIEPENBROCK ET AL. 2000). The ranking of treatments according to the number of siliques and yield usually corresponds to the fertilization level (VEROMANN ET AL., 2013).

After 1995, many rape cultivars and hybrids were introduced in Romania, generally with a low erucic acid content (below 2%). The oil from these seeds can be used in human food and the groats can be used in animal feed. Rapeseed oil is used in human food, pharmaceuticals and biofuels. At the moment, between 400,000 and 500,000 ha per year are grown in our country every year. The growth of rapeseed areas in our country results from the introduction of cultivars and hybrids free of erucic acid and glucosinolates, the cultivation of varieties and hybrids resistant to wintering and falling off, the full mechanization of the crops, the high demand of rapeseed on the external and internal market, especially for fuel production (MARIN, 2011).

Rapeseed grows well in areas with annual rainfall ranges between 450-650 mm with a maximum in July-August and an average annual temperature of 7-10 degrees Celsius, without big frosts and enough snow cover.

Rapeseed requires a high fertilization being a great nutrients consumer. For one tonne of seeds and related biomass production, specific consumption is 50-60 kg nitrogen, 30-60 kg phosphorus, 40-50 kg potassium, 50-60 kg calcium, 20-30 kg sulfate and significant quantities of microelements. Nitrogen is the most important fertilizer applied to canola in terms of cost to growers, and inadequate or untimely N applications often restrict yields. Nitrogen deficit leads to fewer and smaller leaves than N-sufficient plants (MENDHAM ET AL., 1981). Nitrogen fertilizer increases yield by influencing a variety of growth parameters such as the number of branches per plant, the number of pods per plant, the total plant weight, the leaf area index. Also, it increases the number and weight of pods, seeds and flowers per plant, and overall crop assimilation, contributing to increased seed yield (WRIGHT ET AL., 1988).

MATERIAL AND METHODS

Experimental site

The research was carried out during the agricultural year 2016-2017 in Ialomita County which is located in the southeastern part of the country, in the Baragan Plain, an eastern division of the Wallachian Plain. The experience was conducted on a plot of 20 ha.

Rapeseed hybrid

For aforementioned study, the Vesuvio rapeseed hybrid has been sown. It is a mid-early hybrid, distinguished by strong branching and increased yield. As well, it has good performance on high temperatures, drought conditions and also presents good resistance to frost.

Fertilization and applied treatments

Table 1

Fertilization and treatments scheme

Period of time	Fertilizer and phytosanitary treatments	Dose
August, first decade	NPK 18:46:0	150 kg/ha; 200kg/ha*
August, first decade	sowing, 60 seeds per sqm	2.8 kg/ha
September, second decade	metconazole (30g/L) + mepiquat chloride (210g/L) + deltamethrin (100 g/L)	0.75L/ha
March, first decade	NH_4NO_3	150 kg/ha; 200kg/ha*
March, second decade	thiachloprid (100 g/L) + deltamethrin (10 g/L)	0.5L/ha
	propiconazole (80 g/L) and tebuconazole (160 g/L)	1L/ha
	thiacloprid (240 g/L)	0.3L/ha

*according to experimental scheme

During the research, the rainfall was rather abundant, reaching 193% beside the multiannual average, which allowed a very good development of rape plants.

Soil analyses, methods and instrumentation

Table 2

Analyses, methods and instrumentation

Analyses	Method	Apparatus
pH_{H2O} (1:2.5)	potentiometric	Hanna pH-meter
Potassium (mobile form), K_{AL}	flame emmision spectrometry	Sherwood 410
Phosphorus (mobile form), P_{AL}	spectrophotometry	CECIL 2041 spectrometer
Humus content	Walkley-Black-Gogoașă	-

Plant determinations

Some determinations were performed in the field (the number of lateral branches per plant and the average height of the plant at harvest) and other in the laboratory (number of siliques per plant and on seeds number per silique).

RESULTS AND DISCUSSIONS

At the beginning of the experiment, agrochemical soil analysis indicated that soil reaction was slightly alkaline (pH = 7.25); meanwhile humus content (H) was medium (2.36%). Mobile form of phosphorus (P_{AL}) was classified as high content (72 mg/kg) and potassium content (K_{AL}) was 176 mg/kg which is considered good to medium content. The degree of base saturation is high (91.4%).

Soil agrochemical parameters were evaluated for each experimental variant and the results are presented in table 3. According to the results, soil reaction in all cases is very slightly alkaline, humus content (H) is medium, mobile phosphorus (P_{AL}) is high for V1 and V2 meanwhile for V3 and V4 is very high. Regarding potassium content (K_{AL}), the analyses indicated very high content for all experimental variants.

Table 3

Soil agrochemical parameters for each experimental variant

Variant	**pH**	**H, %**	**$P_{AL,}$ mg/kg**	**$K_{AL,}$ mg/kg**
V1	7.21	2.33	68.0	240
V2	7.24	2.42	66.7	210
V3	7.31	2.47	77.2	260
V4	7.22	2.52	79.2	220

Following the influence of fertilization on rapeseed yield, it was observed that the application of increasing fertilizer doses resulted in significant yield differences. The highest values were recorded for V3 (DAP 200 kg/ha + NH_4NO_3 150 kg/ha) with 3958 kg/ha and V4 (DAP 200 kg/ha + NH_4NO_3 200 kg/ha) with 4156 kg/ha, respectively 110% and 116% as against V1 (100%) that was considered as control variant. Analysis of variance on the influence of fertilization on rapeseed yield shows significant differences for all experimental variants. (Table 4).

Table 4

The influence of mineral fertilization (factor a) on rapeseed yield

Variant	Fertilization scheme	Rapeseed yield, kg/ha
V1	a1 = 18-46 DAP 150 + NH_4NO_3 150	3584 d
V2	a2 = 18-46 DAP 150 + NH_4NO_3 200	3676 c
V3	a3 = 18-46 DAP 200 + NH_4NO_3 150	3958 b
V4	a4 = 18-46 DAP 200 + NH_4NO_3 200	4166 a
LSD 5%=85 * kg/ha ; LSD 1%=129 kg/ha; LSD 0.1%=208 kg/ha		

Regarding the influence of fertilization on the average height of rapeseed plant (cm), the application of increased fertilizer doses resulted in significant differences in height between V1 variant (18-46 DAP 150 kg/ha + NH_4NO_3 150 kg/ha, which means 77 kg N/ha) and V4 (18-46 DAP 200 kg/ha + NH_4NO_3 200 kg/ha, which means 103 kg N/ha). The highest height was observed at V4 (+10 cm) against V1. The insignifiant height difference between V2 (18-46 DAP 150 kg/ha + NH_4NO_3 200 kg/ha) and V3 (18-46 DAP 200 kg/ha + NH_4NO_3 150 kg/ha) is given by the amount of nitrogen (94 kg/ha on V2 compared to 86 kg/ha on V3, a difference of only 10 kg N/ha). The analysis of variance on the influence of fertilization on the average height (cm) of the rapeseed plant shows significant differences between V4 and V1 variants and no significant differences between V2 and V3 variants (Table 5).

Table 5

The influence of mineral fertilization (factor a) on average height of rapeseed plant at harvest time

Variant	Fertilization scheme	Average height of rapeseed plant at harvest time, cm
V1	a1 = 18-46 DAP 150 + NH_4NO_3 150	160 c
V2	a2 = 18-46 DAP 150 + NH_4NO_3 200	165 b
V3	a3 = 18-46 DAP 200 + NH_4NO_3 150	164 b
V4	a4 = 18-46 DAP 200 + NH_4NO_3 200	170 a
LSD 5%=2.99* cm ; LSD 1%=4.54 cm; LSD 0.1%=7.29cm		

Following the influence of fertilization on the number of lateral branches per plant, there are no significant differences since the plants had a uniform growth and development, without being in competition against each other. The analysis of variance on fertility influence on the number of lateral branches per plant indicates no significant differences for experimental variants V2, V3 and V4 and significant differences against to the control variant V1 (Table 6).

Table 6

The influence of mineral fertilization (factor a) on the number of lateral branches per plant

Variant	Fertilization scheme	Number of lateral branches/plant
V1	a1 = 18-46 DAP 150 + NH_4NO_3 150	7.0 b
V2	a2 = 18-46 DAP 150 + NH_4NO_3 200	7.2 a
V3	a3 = 18-46 DAP 200 + NH_4NO_3 150	7.3 a
V4	a4 = 18-46 DAP 200 + NH_4NO_3 200	7.3 a
LSD 5%=0.19* branches/plant.; LSD 1%=0.28 branches/plant; LSD 0.1%=0.46 branches/plant		

Regarding the influence of fertilization on the number of siliques per plant, there are no significant differences between V2, V3 and V4. Significant differences between V1 variant (18-46 DAP 150 kg/ha + NH_4NO_3 150 kg/ha) against V2 (18-46 DAP 150 kg/ha + NH_4NO_3 200 kg/ha), V3 (18-46 DAP 200 kg/ha + NH_4NO_3 150 kg/ha) and V4 (18-46 DAP 200 kg/ha + NH_4NO_3 200 kg/ha) are determined by the superior fertilization levels (Table 7).

Table 7

The influence of mineral fertilization (factor a) on the number of siliques per plant

Variant	Fertilization scheme	Number of siliques per plant
V1	a1 = 18-46 DAP 150 + NH_4NO_3 150	82.0 b
V2	a2 = 18-46 DAP 150 + NH_4NO_3 200	82.5 a
V3	a3 = 18-46 DAP 200 + NH_4NO_3 150	82.6 a
V4	a4 = 18-46 DAP 200 + NH_4NO_3 200	82.6 a
LSD 5%=0.19* siliques/plant; LSD 1%=0.30 siliques/plant; LSD 0.1%=0.48 siliques/plant		

Following the influence of fertilization on seeds number per silique, there are significant differences between V1 (18-46 DAP 150 kg/ha + NH_4NO_3 150 kg/ha) and V2 (18-46 DAP 150 kg/ha + NH_4NO_3 150 kg/ha) versus V3 (18-46 DAP 200 kg/ha + NH_4NO_3 150 kg/ha) and V4 (18-46 DAP 200 kg/ha + NH_4NO_3 200 kg/ha). The higher seeds number on V3 and V4 is determined by the amount of applied phosphorus (69 kg P_2O_5/ha at V1 and V2 versus 92 kg P_2O_5/ha at V3 and V4). It is known that phosphorus stimulates the flowering and fructification of plants. The analysis of variance on the fertilization influence on seeds number per silique indicates significant differences for V1 and V2 against V3 and V4 (Table 8).

Table 8

The influence of mineral fertilization (factor a) on seeds number per silique

Variant	Fertilization scheme	Seeds number per silique
V1	a1 = 18-46 DAP 150 + NH_4NO_3 150	18 a
V2	a2 = 18-46 DAP 150 + NH_4NO_3 150	18 a
V3	a3 = 18-46 DAP 200 + NH_4NO_3 150	19 b
V4	a4 = 18-46 DAP 200 + NH_4NO_3 200	20 b
LSD 5%=1.28* seeds/silique; LSD 1%=1.95 seeds/silique; LSD 0.1%= 3.14 seeds/silique.		

CONCLUSIONS

The influence of fertilization on rapeseed yield is considerable. Compared to the first fertilization variant, the application of additional fertilizer doses caused significant yield differences.

The results indicated that application of additional fertilizer doses led to significant yield differences for V3 (110%) and V4 (116%) as against V1 (100%) that was considered as control variant. Variant V2 has no significant yield increase versus V1 (102%).

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