EFFECT OF MOISTURE, NITROGEN DOSES AND SOIL ACIDITY ON SEED YIELD, CHEMICAL COMPOSITION AND THOUSAND SEED WEIGHT OF SOME WINTER OILSEED RAPE CULTIVARS

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INTRODUCTION

According to Klatt the water requirement of winter oilseed rape in the period of its intensive growth and seed formation under Central Europe conditions can be satisfied by about 200 mm of rainfall (Borysiak 1979).

In Poland this period falls between April and June. Rainfall at that time is by about 50 mm lower and moreover, periodically droughts frequently occur in these months.

The water deficiency in the rape cultivation is the subject of interest in researches conducted in various countries, especially where this species is cultivated extensively (Dembinska 1970; Borysiak 1979; Clarke et al. 1987; McPherson et al.; 1987; Richards and Thurling 1978).

Soils in more than half of the arable land in Poland are highly acidic and contains high amounts of active Al^{+++} and Mn^{++} ions. This decreases the growth of plants, particularly roots (Barszczak 1987) and exerts a negative effect on the utilization of water and nutrients.

The hypothesis has been formulated that the adaptation of particular cultivars to growth under conditions of insufficient soil moisture and increased acidity would be interdependent. This hypothesis has been verified in the present investigation.

MATERIALS AND METHODS

Two low erucic "0" cultivars: Jupiter and Jet Neuf and double low quality ("00") cultivars and strains: Jantar, Bolko, BOH-585, BOH-785 and POH-385 were used in the investigation.

The experiments were carried out in accordance with the following scheme:

- Factor A - 2 soil moisture levels,
- Factor B - 7 cultivars and strains,
- Factor C - 3 different soil pH values,
- Factor D - 2 nitrogen doses.

In 1988 the investigation of all factors were carried out.

In 1989, only one nitrogen rate and in 1990 only one soil pH value were applied.

The investigation was carried out under field conditions on an experimental site. It consisted of pots and ceramic cylinders without bottoms, 150 cm in height and 40 cm in diameter. The pots were placed in a trench in such a way that their surface was equal to the field surface level. The pots were filled with the soil profile of the same mechanical composition, but different acidity. The upper layer of the profile had the mechanical composition of loamy sand, and the deeper layer had that of medium loam. The open bottom in the pots ensured a natural vertical water movement. The frame for a polythene tunnel was fitted over the pots. This enabled the polythene cover to be fitted during various plant growth phases in order to simulate different rainfall doses by watering. The ends of the tunnel were Ieft open to facilitate air movement above the plants.

Chemical and agricultural properties of the soil are presented in Table 1.

Table 1. Characteristics of soils used in experiments.

Soil Denotation	Horizon in cm	Acidity				Content of Exchange-able Cations in mg/100 g of Soil			
		pH_{KCl}	Hh me /100 g	Hw me /100 g	Al ppm	Ca	Mg	J	Na
C_1	0-25	6.2	1.08	0.00	0.0	77.1	2.2	6.8	2.6
	25-50	6.1	1.27	0.00	0.0	97.0	6.6	5.0	4.1
	50-75	5.2	1.25	0.00	3.6	59.5	3.8	3.9	2.9
	75-105	4.7	1.39	0.04	11.7	46.0	3.0	4.8	2.3
C_2	0-25	5.1	1.67	0.03	9.9	44.6	1.8	5.9	1.5
	25-50	4.7	1.61	0.13	16.2	63.5	4.9	5.1	2.7
	50-75	4.6	1.69	0.08	32.4	57.0	3.3	4.9	2.7
	75-100	4.6	1.53	0.00	15.3	51.5	3.3	4.5	2.5
C_3	0-25	4.2	2.64	0.09	50.4	29.4	1.8	6.3	1.4
	25-50	4.3	2.14	0.09	43.2	69.5	5.0	6.3	2.9
	50-75	4.5	2.02	0.04	41.4	17.0	1.0	1.2	1.0
	75-105	4.4	2.09	0.04	31.5	51.0	3.1	5.2	3.6

$A_1 - A_2$ = 105 - 111 mm, D_1 = 150 kg N/ha, D_2 = 300 kg N/ha

Before sowing, the basic fertilization was applied at the doses of 30 kg N, 80 kg P_2O_5, 120 kg K_2O and 30 kg MgO per hectare.

The nitrogen fertilization was applied at the start of growth in spring at the doses of 150 and 300 kg N per hectare in the form of NH_4NO_3.

The experiment was carried out on an open site until the start of budding of the rape. From that time the polythene was stretched over the tunnel frame, and moisture differentiation by watering began. When the rape plants completed flowering the polythene was removed, and further cultivation continued on an open site. In particular years, differences in watering in the A_1 treatments (higher soil moisture) compared to the A_2 treatments (less soil moisture) ranged from 105-111 mm.

The harvest occurred in the phase of technical maturity of the seeds.

RESULTS

The statistical analysis of variability for the seed yield showed significant differences caused by the following factors: periodical drought (A), cultivars (B), soil acidity (C) and nitrogen rate (D). Also, significantly different reactions of cultivars to the soil drought (C) and the nitrogen dose (D) were found. The effect of the BC and BD interaction were proved statistically. On the other hand, no significant effect of the interaction of cultivars and soil acidity BA occurred but decrease in the yield of winter oilseed rape from the effect of soil acidity were proved. This suggests that this decrease was similar for all cultivars and strains investigated, since the relationships were generally parallel.

The influence of soil drought on the rapeseed yield was very strong (Table 2). The moisture change within the investigated range led to significantly lower yields in all cultivars although to a different degree. The lowest change of the seed yield resulting from soil drought was found in the cultivar Jet Neuf. It appeared to be relatively tolerant to the water deficiency.

Table 2. Effect of soil moisture, acidity and nitrogen rate on the seed yield of winter oilseed rape in g per pot with a surface of 0.125 m^2.

Factors Investigated	Cultivars (B)							
	Jupi-ter	Jet Neuf	Jantar	BOH-585	BOH-385	POH-385	Bolko	Mean
Soil Moisture	3-Year Mean 1980-1990							
A_1	63.3	56.5	58.0	54.2	57.2	57.4	61.3	58.3
A_2	51.8	48.7	46.3	40.4	40.4	42.5	45.8	45.1
Mean	57.6	52.6	52.1	47.3	48.8	50.0	53.6	51.7
Soil Acidity	2-Year Mean 1988-1989							
C_1	64.1	58.7	61.85	3.7	53.5	57.8	59.6	58.5
C_2	55.0	52.1	55.1	46.8	50.0	52.3	54.6	52.2
C_3	52.1	46.7	49.8	41.8	45.7	44.6	48.5	47.0
Nitrogen Doses	2-Year Mean 1988 and 1990							
D_1	46.0	41.6	38.3	36.8	35.7	35.6	39.0	39.0
D_2	57.4	52.2	49.7	46.1	48.8	48.4	55.0	51.1

A_1 - A_2 = 105 - 111 mm, C_1, C_2, C_3 - See Table 1,
D_1 = 150 kg N/ha, D_2 = 300 kg N/ha

$LSD_{(P=0.05)}$: A = 1.44, A/B = 4.02, B = 3.40, B/A = 4.64,
B/D = 4.80, C = 2.34, D = 2.02, D/B = 4.41

On the other hand, the Bolko variety and the BOH-585, BOH-785 and POH-385 strains proved to be relatively susceptible to drought.

Soil moisture distinctly affected the varietal differences in the seed yield. At higher soil moisture level the Bolko cultivar gave a significantly higher yield as compared to the Jet Neuf cultivar, while the yields of the BOH-585, BOH-785 and POH-385 strains remained at the level of the Jet Neuf cultivar. With periodical soil drought the seed yield of the Jet Neuf cultivar was higher than that of the Bolko cultivar but not statistically significant (Table 2).

Increased nitrogen dose led to different yield increases in particular cultivars. This increase was the highest in the cultivar Bolko (Table 2).

The factors investigated in the experiment caused changes in the fat and protein content of seeds. Increase in nitrogen fertilization led to a decrease in the fat content and an increase in the protein content (Table 3). There was a slight increase in protein content as a result of soil acidity (probably due to lower seed yield at the same mineral nitrogen level in soil). However, the fat content was slightly lower by higher soil acidity.

A reduction of the soil moisture did not cause any changes in the fat and protein contents of the rapeseeds (Table 3).

Table 3. Fat and protein content in seed of winter oilseed rape depending on soil moisture, acidity, nitrogen doses and cultivars (in per cent of dry matter).

Factors Investigated	Content		Cultivars (B)	Content	
	Fat	Protein		Fat	Protein
Soil Moisture					
A_1	46.6	18.7	Jupiter	44.7	17.9
A_2	46.8	18.9	Jet Neuf	44.2	19.6
Soil Acidity					
C_1	47.4	18.4	Jantar	48.6	18.2
C_2	46.9	18.9	BOH-585	47.8	18.9
C_3	46.7	18.9	BOH-785	48.5	18.8
Nitrogen Doses			POH-385	48.0	18.9
D_1	46.3	19.0	Bolko	46.2	19.2
D_2	45.1	20.2			

A_1 - A_2 = 105 - 111 mm, C_1, C_2, C_3 - See Table 1,
D_1 = 150 kg N/ha, D_2 = 300 kg N/ha

Relatively high differences in the fat and protein content of winter oilseed rape depended on cultivars. The highest protein content was in the Jet Neuf seed which at the same time were characterized by the lowest fat content and relatively high thousand seed weight (TSW).

The highest fat content was in seed of the Jantar cultivar which were characterized by a relatively low TSW and low protein content.

The above comparisons substantiated the calculations determining the dependence of TSW on the fat and protein contents. These interactions were determined by the linear regression function as follows:

$$y = 2.159 + 0.139\, x_1,$$
$$y = 8.165 - 0.069\, x_2$$

where: y = TSW, x_1 = protein content (%), x_2 = fat content (%).

CONCLUSIONS

The cultivars and strains of winter oilseed rape showed:
- different reactions to periodical soil drought. Most tolerant proved to be the cultivar Jet Neuf and most susceptible, the cultivar Bolko.

- different response to nitrogen fertilization. The Bolko cultivar had the strongest reaction to the nitrogen fertilization.

- similar reactions to soil acidity change within the range investigated.

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