COMPARATIVE VARIETY EXPERIMENT OF WINTER RAPES (BRASSICA NAPUS L.) HYBRIDS IN 2020.

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Abstract. *The rape (Brassica napus L.) is currently one of the most important oilseeds in Europe. In terms of cultivation technology and growing season, we distinguish between winter rape and spring rape. In Hungary, the former is widespread due to higher yields. Rapeseed is grown on more than 25 million ha in the world, the amount of rapeseed produced annually is close to 45 million tons, the average yield is around 1.5 t / ha. In Hungary, in recent years this number has been around 2.5-3.0 t / ha, and its sown area is almost 300 000 ha, depending on the crop rotation. During the growing season of rapeseed, it requires a cooler or moderately warm, frost-free, rainy, humid, climate appropriate to its place of origin. Winter frosts are mainly affected by late-sown, late-hatched, so poorly developed rapeseed, while rapeseed, which has been strengthened until the onset of winter, can withstand dry frost. Variety experiment was set up in Szarvas at the experimental site of the Institute of Irrigation and Water Management of Szent István University in 2020. In the experiment, 12 hybrid rapeseeds were studied in a small-plot, triple-repeat randomized arrangement. The size of the plots was 18 m2. In the course of the research, we conducted autumn and spring surveys to monitor plant development. We also performed pathological bonifications during the spring, because today the cultivation of a modern hybrid can only be successful if it has sufficient resistance to the most important domestic rapeseed pathogens. Before harvest, we counted the number of branches, the length of the branches, the number of buds, and the length of the buds on the average samples taken from each hybrid plant. Of course, the yields obtained after harvest were compared and statistically evaluated together with the individual measurement results. In the case of the autumn development studies, we found that we start the winter with a good, medium-homogeneous development stock for the experiment. No meaningful difference was found between the hybrids. In the spring development studies of 2020, we concluded that the severe drought in winter did not significantly tolerate rapeseed stocks. During the pathological bonification, the recording was performed on a scale of 1 to 9. Where 1 was the highest infection and 9 was the infection-free herd. The data of the surveys showed that, apart from one or two minimal deviations, the herd could be considered infection-free for the most important rape pathogens. When examining the crop-forming elements and the yield, we already found differences between the individual hybrids. These differences were also statistically significant. Overall, yield averages ranged from 2.4t / ha to 4.4t / ha.*

Keywords:*rape hybrid, variety experiment, yield*

INTRODUCTION

The rape (Brassica napus L.) is currently one of the most important oilseeds in Europe. In terms of cultivation technology and growing season, we distinguish between winter rape and spring rape. In Hungary, the former is widespread due to higher yields. Rapeseed is grown on more than 25 million ha in the world, the amount of rapeseed produced annually is close to 45 million tons, the average yield is around 1.5 t / ha. In Hungary, in recent years this number has been around 2.5-3.0 t / ha, and its sown area is almost 300 000 ha, depending on the crop rotation. During the growing season of rapeseed, it requires a cooler or moderately warm, frost-free, rainy, humid, climate appropriate to its place of origin. Winter frosts are mainly affected by late-sown, late-hatched, so poorly developed rapeseed, while rapeseed, which has been strengthened until the onset of winter, can withstand dry frost.

The increase in rapeseed production only occurred when its use for human and animal consumption began. From the middle of the 19th century, its cultivation increased, and its oil was used primarily for industrial purposes and animal feed. The growing interest of the industry (biodiesel) and the appearance of modern varieties and hybrids gave a big boost to its cultivation (PERÉDI 1968, BOCZ 1992, EŐRI 2001, KOLE 2007, FALUSI ET AL. 2007). Nowadays, the interest of the industry has grown significantly, rapeseed has become a strategically important crop. As a result of global demand, producer and stock exchange prices also rose in Hungary. Due to this, as well as the application of modern varieties and hybrids, the development of technology has greatly improved the profitability of rapeseed production (KISS 2013, TIKÁSZ 2013). Rapeseed is one of the most important edible oilseeds in the world and a potential source of biodiesel in Europe (WANG 2005).

In Hungary, rapeseed has recently become one of the most dominant crops, largely due to the growing demand for vegetable oils (HINGYI 2005, PEPÓ 2010, TIKÁSZ 2013)

The most important of the cultivation purposes is to use it as cooking oil. Previously, its use in this direction was prevented by the content of substances harmful to the human body, especially erucic acid. By breeding, practically erucic acid-free double zero hybrids have been produced, the oil of which is also used as cooking oil and for the production of margarine. According to BOCZ (1996), the average demand for rapeseed fertilizer, taking into account the national average yield and soil conditions:

Nitrogen 50 - 110 kg / ha

Phosphorus 70 - 80 kg / ha

Potassium 80 - 100 kg / ha

According to HOFFTMANN (2011), the parameters of rapeseed sowing are as follows: l. Number of plants: Decreased in varieties for new hybrids (many branches, many seedlings, and this requires a larger growing area) 2. Target for spring: in the case of hybrid oilseed rape: 50-60 seedlings / m2, (this requires 0.6-0.8 million germs; 2.5-3.5 kg / ha seeds). 3. In the case of rapeseed variety: 80-100 seedlings / m2, (this requires 1.0-1.4 million germs; 4-6kg / ha seeds). 4. Under unfavorable conditions, a seed surplus of 10-15% is required. 5. Row spacing used: double grain row spacing (24 cm), 6. Applied sowing depth: 2-3 cm. The row spacing is 12-36 cm, but is most often sown at 24 cm row spacing Seed requirement: 5-8 kg / ha, which corresponds to 1.2 million6 germs per hectare. The sowing depth is 1.5-3 cm depending on the soil binding. After sowing, it is usually rolled, with a ring roller on loose soil and a smooth roller loosely. According to UDVARDY (2010), rapeseed is the earliest autumn sown crop. Sowing time is the last third of August, early September. Hybrid varieties, however, before mid-September don't take it. The row spacing is grain spacing (12 cm), double or triple grain spacing, sowing depth 1.5-3 cm. Seed needs are 5-8 kilograms, which means 1.6-1.8 million germs per hectare for conventional varieties, hybrids are sown with 3-4kg / ha of seed. Regarding the plant protection of rapeseed, it is recommended to control mainly Sclerotinia, Botritys, Alternaria but even Phoma species during flowering. In parallel with the increase in its production area, the number of pests also increased. Pest control requires constant attention. Many insect species can cause damage to the development of rapeseed, and these species have a large number of individuals (EŐRI 2000, BÓDIS-PETŐHÁZI 2007, KÁTAI 2011, FARKAS 2011, 2013 HERTELENDY 2013)

MATERIAL AND METHODS

Variety experiment was set up in Szarvas at the experimental site of the Institute of Irrigation and Water Management of Szent István University in 2020. In the experiment, 12 hybrid rapeseeds were studied in a small-plot, triple-repeat randomized arrangement. The size of the plots was 18 m2. In the course of the research, we conducted autumn and spring surveys to monitor plant development. We also performed pathological bonifications during the spring, because today the cultivation of a modern hybrid can only be successful if it has sufficient resistance to the most important domestic rapeseed pathogens.

The soil of the experimental area is deeply carbonated chernozem meadow soil. The main characteristics of the soil of the experiment: its physical type is clayey loam, its pH is acidic or slightly acidic, the cultivated layer does not contain CaCO3, based on the humus content, the N-supply of the soil is medium. The NO3-N content of the soil in the control treatment was 19.8 mg / kg. The P, K, Mg and Mn supply is excessive and the Zn and Cu supply is good. Soil water management is characterized by poor water conductivity and high water holding capacity. The Asz level is compacted, its total porosity, and within this, the proportion of gravitational pores is smaller. The lower levels are high in clay, cracked, which explains the high water conductivity values.

Table 1.

Characteristics of the soil experiment (Szarvas, 0-30 cm soil layer) Source: Author 's own editing

Soil property	Test value			Average value
	1.	2.	3.	
pH (KCl)	4.93	4.92	4.89	4.91
K_A	42	44	45	43,6
$CaCO_3$ [%]	0		0	0
Humus [%]	2.91	3.00	2.91	2.94
AL-P_2O_5 [$mgkg^{-1}$]	224	182	227	211
AL-K_2O [$mgkg^{-1}$]	250	248	267	255
Mg(KCl) [$mgkg^{-1}$]	695	729	668	697
EDTA-Zn [$mgkg^{-1}$]	3.28	2.86	3.36	3.16
EDTA-Cu [$mgkg^{-1}$]	7.42	7.31	7.50	7.41
EDTA-Mn [$mgkg^{-1}$]	442	436	435	437

The weather for the growing season of the experiment is summarized in Table 2.

Table 2.
Data of weather between aug. of 2019. and jun. of 2020. Szarvas ,Source: Author 's own editing

Month (1)	aug	sept	okt	nov	dec	jan	febr	march	apr	may	jun	sum / aver age
Temperature (°C)	24,1	19,3	13,1	9,5	3,7	-1	5,7	7,4	12,2	15,1	20,7	11,8
Rain (mm)	27	51	49,4	61,1	23,2	12,2	66,7	57,4	13	37	7	405
Mean of rainfall of 30 years (mm)	56,4	42,8	47,8	48,2	44,7	30,6	31,4	28,9	41,9	62,9	71,4	507
Difference (mm)	**-29,4**	**8,2**	**1,6**	**12,9**	**-21,5**	**-18,4**	**35,3**	**28,5**	**-28,9**	**-25,9**	**-64,4**	**-102**

From the obtained results it can be read that the precipitation was more than 100 mm less during the growing season compared to the 30-year average. Due to the favorable rainy weather in September and the average rainfall but favorably warm October, the development of rapeseed was moderate. As the winter of 2019/2020 was less cold, but the winter was extremely dry without rainfall.

The experimental parcels size 1,8m x 10m. Sowing was carried out with a Wintersteiger plott seeder for the whole experimental area. After rising, we have paved roads with rotary cultivator to form the parcels.. Harvesting was done with a parcel harvester. Autumn and spring weed control was also performed in the experiment. In autumn, we typically controlled against monocotyledonous weeds, while in spring we controlled against dicotyledonous weeds. Insect control was performed 3 times in the experiment.

In the experiment, the properties of the following rapeseed hybrids were compared:

1. BASALTI CS
2. MEMORI CS
3. MAZARI CS
4. SIRTAKI CS
5. CELEBRITI CS
6. SIDONI CS
7. ABUNDI CS
8. ESPRI CS
9. CSZ16072
10. QUANTIKO
11. CSZ17025
12. ETENDAR CL

As can be seen, not only hybrids but also hybrid candidates under state recognition were among the plants tested.

RESULTS AND DISCUSSION

Examination of winter oilseed rape was performed by a field bonitation in October and then by a bonitation evaluating spring overwintering. Bonitation was based on a scale from 1 to

9, with the best value being 9 and the weakest value representing the death or freezing or poor development of the plant being 1.

Table 3.

Examination of the development and growth vigor of winter oilseed rape 2019 (autumn), Szarvas Source: Author 's own editing

Hybrid	Date of sowing	Condition at germination	Tendency to stretch	Stopping the vegetation of the hatched stock
1.	2019.09.14	7	9	9
2.	2019.09.14	7	9	9
3.	2019.09.14	8	9	9
4.	2019.09.14	8	8	9
5.	2019.09.14	8	9	9
6.	2019.09.14	8	9	9
7.	2019.09.14	8	7	8
8.	2019.09.14	8	8	8
9.	2019.09.14	8	8	9
10.	2019.09.14	8	9	9
11.	2019.09.14	8	8	9
12.	2019.09.14	9	9	8

From the point of view of hybrids, it is not incidental what the overwintering of the herd is, whether there is a difference between the individual genotypes. As the winter period of 2019/2020 was less cold, but the winter was extremely dry without precipitation, we also performed spring bonification for the reliability of the experiment, according to which the hybrids have a greater tolerance or possibly sensitivity to cold in a water-deficient environment. In the case of rapeseed hybrids, it can be said that the severe drought in winter did not tolerate the rapeseed stocks significantly.

Table 4.

Examination of the development and growth vigor of winter oilseed rape 2020 (spring), Szarvas. Source: Author 's own editing

Hibrid	Growth starts again, 1 late - 9 early	Flowering time, 1 late - 9 early	Plant height (cm)
1.	9	7	123
2.	9	7	133
3.	8	7	137
4.	9	8	136
5.	9	7	111
6.	9	8	117
7.	9	8	125
8.	8	7	131
9.	9	7	134
10.	9	8	118
11.	9	7	123
12.	9	7	112

The overwintering of the rape experiment was judged to be very good overall. Winter damage meant drought-induced leaf dehydration and a weaker spring onset of the stems, but only a very minimal proportion of dead stems were found. At the time of flowering uptake and at the time of plant height measurement, the hybrids showed no potential detrimental effect of winter.

Pathological bonification played a prominent role in the experiment because today the cultivation of a modern hybrid can only be successful if it has adequate resistance to the most important domestic rapeseed pathogens. During the experiment, the following pathogens were recorded and bonified:

- Phoma (Leptosphaeria maculans)
- Cylindrosporiose (Cylindrosporium concentricum)
- Oidium (Erysiphe cruciferarum)
- Verticilium (Verticilium longisporum)
- Other: Hernia, Alternaria

Table 5

Pathological bonification of autumn oilseed rape, 2020. Szarvas Source: Author 's own editing

Hybrid	**Phoma (Leptosphaeria maculans)**	**Cylindrosporiose (Cylindrosporium concentricum)**	**Oidium (Erysiphe cruciferarum)**	**Verticilium (Verticilium longisporum)**	**Other: Hernia, Alternaria**
1.	8	9	7	9	9
2.	9	9	8	9	9
3.	9	9	7	9	9
4.	8	9	8	9	9
5.	8	9	8	9	9
6.	8	9	8	9	8
7.	9	9	9	9	9
8.	9	8	8	9	9
9.	9	9	8	9	9
10.	9	8	9	9	9
11.	8	9	8	9	9
12.	9	9	7	9	9

During the bonification, the recording was performed on the basis of the usual 1-9 support scale. Where 1 was the highest infection and 9 was the infection-free herd.

Of course, the main element of our studies is the evolution of the yield results of different rapeseed hybrids. From the obtained results, we examined with the help of a statistical program that there is this significant difference between the individual hybrids and I also displayed the 95% confidence level limits. The evolution of yields and the limits of the 95% confidence level are shown in Table 6 and Figure 1.

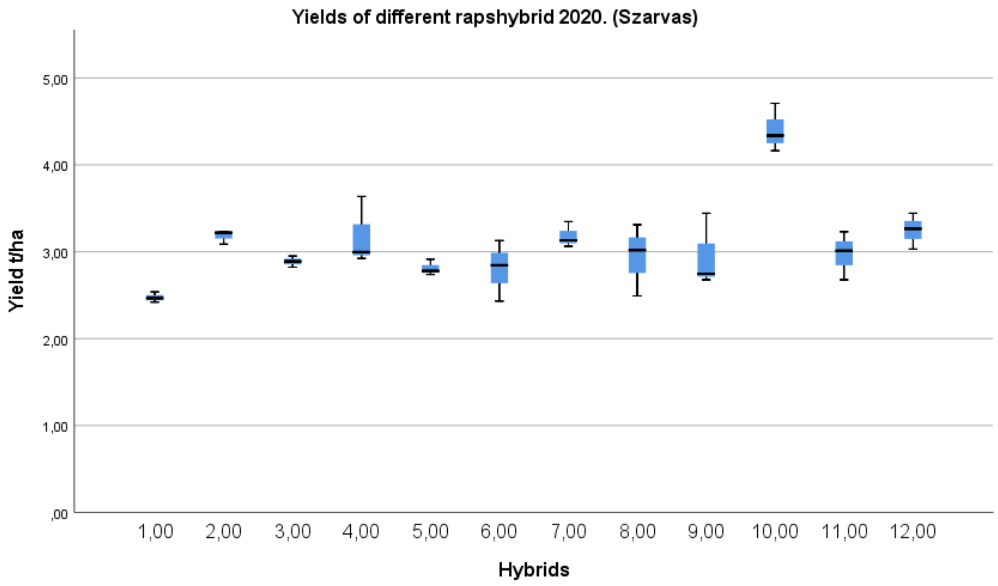

Figure 1: Change of yield of rapshybrids (t ha-1) in 2020 Source: Author 's own editing

Table 6.

Yield averages and 95% confidence limits Source: Author 's own editing

Hybrid				
Dependent Variable: Yield				
Hybrid	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1.00	**2,475**	**,156**	**2,154**	**2,796**
2.00	3,181	,156	2,860	3,502
3.00	2,888	,156	2,567	3,209
4.00	3,185	,156	2,864	3,506
5.00	2,811	,156	2,490	3,132
6.00	2,802	,156	2,481	3,123
7.00	3,182	,156	2,861	3,503
8.00	2,941	,156	2,620	3,262
9.00	2,956	,156	2,635	3,277
10.00	**4,403**	**,156**	**4,082**	**4,724**
11.00	2,973	,156	2,652	3,294
12.00	3,246	,156	2,925	3,567

After examining the results, we wondered whether the differences obtained reached this limit of significance in a statistically verifiable manner. For this, an analysis of variance was performed. The table of variance of the yield results is given in Table 7. The results of the analysis of variance clearly demonstrated that the differences in yield results were significant

Table 7.

Table of variance analysis of yield 2020

Tests of Between-Subjects Effects					
Dependent Variable: Yield					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	7.223[a]	11	,657	9,051	,000
Intercept	343,009	1	343,009	4728,433	,000
Hybrid	7,223	11	,657	9,051	**,000**
Error	1,741	24	,073		
Total	351,972	36			
Corrected Total	8,964	35			
a. R Squared = ,806 (Adjusted R Squared = ,717)					

In a given vintage, under given soil conditions, the number 10 hybrid, QUANTIKO, became the best-producing hybrid based on the yield results. It achieved nearly 2 tons higher yield than the worst performing hybrid the number 1 in the experiment, which was the BASALTI CS. The other hybrids represented average levels under given conditions

CONCLUSIONS

In our field small plot rapeseed experiment, we examined 12 hybrids and hybrid candidates. Developmental studies were performed in the fall and spring. In the spring, we also supplemented our research with pathological bonification. No significant statistically difference was found between the hybrids in these studies. A significant difference was found only in the yield results. The hybrid with the best yield potential under the given soil and vintage conditions was the hybrid named Quantiko, which yielded nearly 2 tons more than the plant called Basalti Cs, which finished in last place in terms of yield. The differences were supported by statistical methods

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