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GROWING SEVERAL RAPESEED HYBRIDS FOR GREEN FODDER IN THE CONDITIONS OF CENTRAL SOUTHERN BULGARIA

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Abstract

This experiment aims to establish the productivity and quality of several rapeseed hybrids grown for green fodder in the region of Central Southern Bulgaria. The experiment was conducted for three years (2017-2020) in the experimental field of the Department of Plant Growing at AU Plovdiv, by the block method, in 4 replications, with a harvest plot size of 20 m^2. The subject of the experiment is the hybrids PT225, PT234, PR44W29, and PT271. Harvesting of rapeseed for green mass is done in the flowering phase. It was found that the best ratio of individual parts of plants combined with the highest content of crude protein and the lowest crude fiber was reported in the hybrid PT225. During the three years of the experiment and on average for the study period, the highest yield of green mass was obtained from the hybrid PT234 (69 250 kg/ha).

Key words*: rapeseed, hybrids, green fodder, quality.*

INTRODUCTION

Along with repko, winter rapeseed provides farm animals with the first green fodder, before alfalfa and pre-crops rye, winter peas, and barley. In terms of biochemical properties, rapeseed is superior to many forage crops and is one of the high-protein feeds.

One kilogram of green mass contains 0.16 food units and 30 g of protein, which exceeds that in the green mass of corn, sunflower, barley, and peas. Its coefficient of digestibility of protein in the green mass is one of the highest (80-86%). In its fresh mass, winter rapeseed contains from 9 to 12.5% sugars (glucose, fructose, sucrose) (Nikiforov, 2004; Ivanova et al. 2009; Shpaara, 2012; Ivanova, 2008, 2012; Delchev, 1988).

The yield and quality of the green mass depends on the climatic conditions, the varietal characteristics, the phase of development, the quantity of input fertilizers, and other agrotechnical factors (Ivanova et al., 2009; Todorov, 2012; Jeromela et al., 2010; Mikić et al., 2010).

MATERIALS AND METHODS

The study was conducted in the period 2017 – 2020 in the Educational, Experimental and Implementation Base of the Department of Plant Growing at the Agricultural University Plovdiv.

The experiment is based on a block method, with 4 repetitions with the size of the experimental plot 20 m^2.

Subject of the experiment are hybrids PT234, PT271, PR44W29 and PT 225.

The experiment was carried out after a predecessor of wheat cultivated on the generally accepted cultivation technology.

Sowing is carried out in the optimal timing for rapeseed, at a row spacing of 12-15 cm and sowing rate 12 kg/ha.

Harvesting of rapeseed for green mass is done in the flowering phase.

The analysis of the feed was performed by the so-called Weende method. It determines crude protein, crude fat, crude fiber.

During the years of the experiment, the combination of climatic factors is favourable for the cultivation of rapeseed for green fodder, which allows obtaining high yields.

The data characterizing these factors during the years of the experiment in the areas of the Educational, Experimental and Implementation Base are indicated in (Figures 1 and 2).

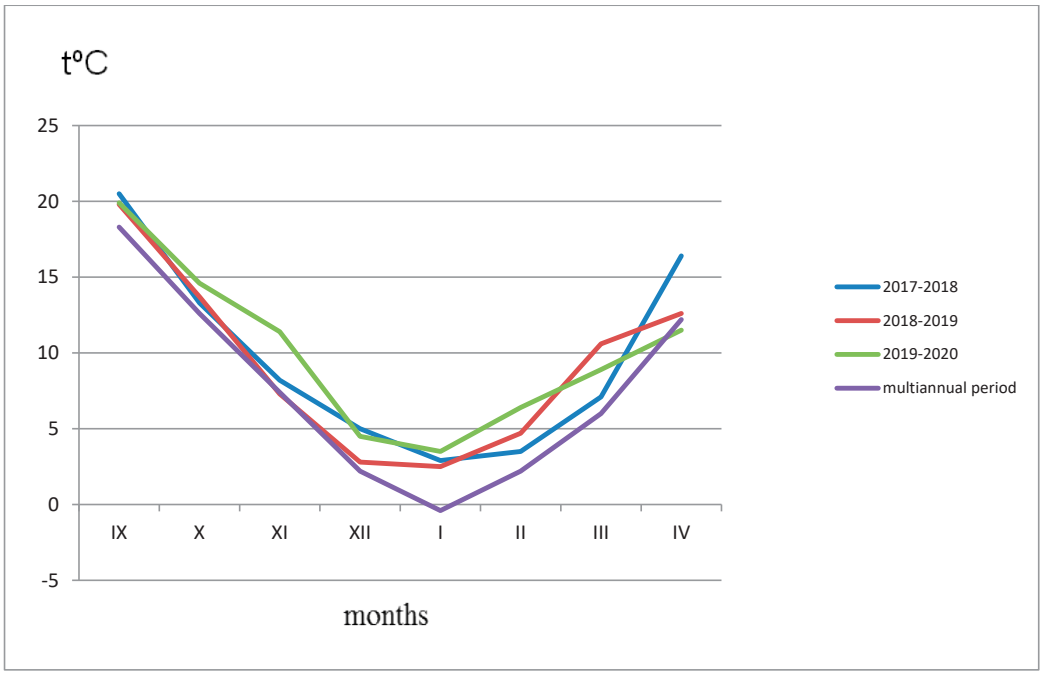

Figure 1. Average monthly temperatures in the region of the Training, experimental and implementation base

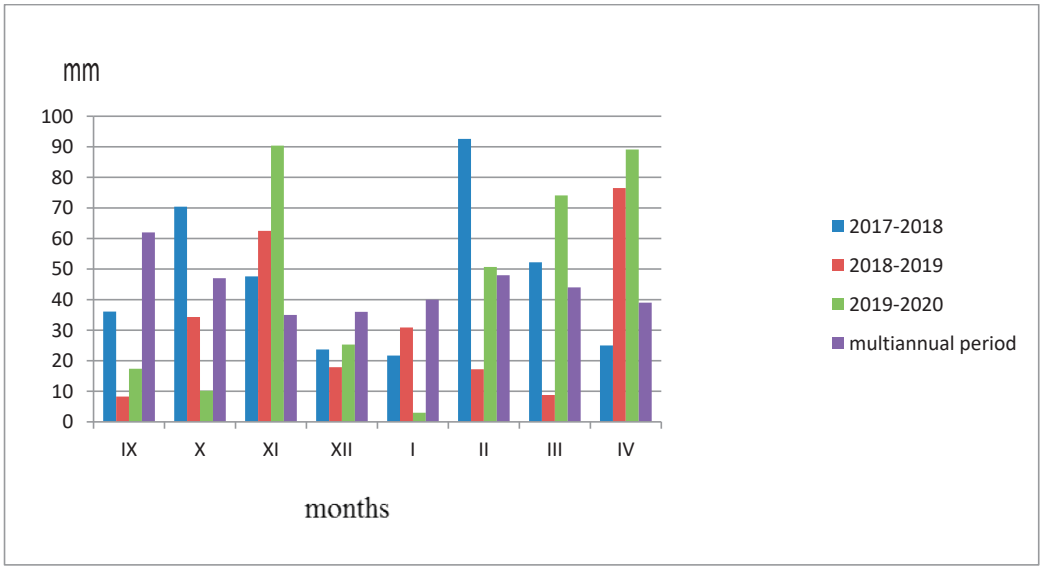

Figure 2. Quantity of rainfall during the years of survey in the region of the Training, experimental and implementation base

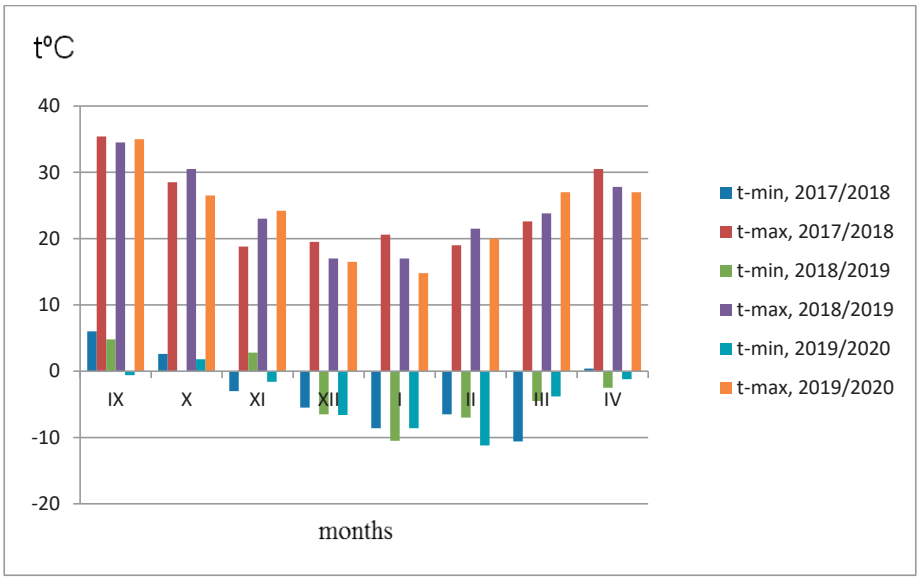

Figure 3. Absolute minimum and maximum temperatures by months 2017/2020

In the growing area, the amount of precipitation before sowing and during the vegetation of rapeseed grown for green fodder was 360.2 mm in 2019-2020, 256.4 mm in 2018-2019, and 369.3 in 2017-2018.

During the second and third year it exceeds by 18.3 mm and 9.2 mm, while in the second it is by 94.6 mm less than the multiannual period (351 mm) (Figure 2).

An absolute minimum temperature during the three years of the study was reported in March 2018 (-10.6°C), in January 2019 (-10.5°C) and in February for 2020 (-11.2°C) (Figure 3).

RESULTS AND DISCUSSIONS

The phases of plant development in the different years occurred at different times (Table 1).

All tested hybrids in the experimental 2018 germinate on 20.09, in 2019 on 27.09, and in 2017 on 28.09.

In all three experimental years, all specimens reached the 6th-8th leaf stage about one month after germination.

During the three years of the experiment the tested hybrids enter phase 6-8th leaf at a different time PT234 (29.10; 26.10; 29.10); PT271 (29.10; 27.10; 29.10); PR44W29 (29.10; 27.10; 30.10) and PT 225 (30.10; 28.10; 30.10).

In the first ten days of December, with a permanent drop in temperature, rapeseed ceases its vegetation. In the first year of the study this period occurs at 12.12, in the second on 9.12, and in the third on 8.12.

A prerequisite for the resumption of vegetation in 2019 on (7.03) was the increase in temperatures in early March 2019 up to 10.9°C

In 2018 and 2020, the resumption of vegetation occurred later on (10.03 and 9.03), respectively.

Stem formation phase lasts for three days, from 24.03 to 27.03.

Table 1. Development stages

Development stages	Years											
	2017/2018				2018/2019				2019/2020			
Hybrids	PT225	PT234	PR44W29	PT271	PT225	PT234	PR44W29	PT271	PT225	PT234	PR44W29	PT271
Sowing	5.09	5.09	5.09	5.09	3.09	3.09	3.09	3.09	5.09	5.09	5.09	5.09
Germination	28.09	28.09	28.09	28.09	20.09	20.09	20.09	20.09	27.09	27.09	27.09	27.09
Sixth to eighth leaf	30.10	29.10	29.10	29.10	28.10	26.10	27.10	27.10	30.10	29.10	30.10	29.10
Termination of vegetation	12.12	12.12	12.12	12.12	9.12	9.12	9.12	9.12	8.12	8.12	8.12	8.12
Restoration of vegetation	10.03	10.03	10.03	10.03	7.03	7.03	7.03	7.03	9.03	9.03	9.03	9.03
Stem formation	27.03	26.03	25.03	25.03	27.03	25.03	26.03	25.03	25.03	24.03	25.03	24.03
Budding	11.04	10.04	10.04	10.04	11.04	9.04	10.04	10.04	10.04	8.04	9.04	9.04
Beginning of flowering - 10%	19.04	18.04	17.04	17.04	20.04	17.04	18.04	18.04	17.04	15.04	16.04	16.04
Mass flowering – 75%	27.04	25.04	26.04	26.04	28.04	25.04	26.04	27.04	26.04	23.04	25.04	25.04
Vegetation period from germination to mass flowering	212	209	210	211	221	218	219	220	213	210	212	212

Table 2. Structural elements of yield of the studied hybrids

Hybrids	Plant height /cm/				Number of branches per plant /pcs/				Number of leaves per plant /pcs/				Stem thickness /mm/			
	Years															
	2017 2018	2018 2019	2019 2020	Average	2017 2018	2018 2019	2019 2020	Average	2017 2018	2018 2019	2019 2020	Average	2017 2018	2018 2019	2019 2020	Average
PT225	140	137	142	140	6.9	6.8	7.0	6.9	18.4	18.0	18.7	18.4	16.9	16.8	17.1	16.9
PT234	143	140	144	142	7.3	7.1	7.4	7.3	18.9	18.8	19.1	18.9	17.4	17.3	17.5	17.4
PR44W29	141	138	143	141	7.1	7.0	7.2	7.1	18.5	18.3	18.8	18.5	17.1	17.0	17.2	17.1
PT271	138	135	143	139	6.8	6.6	7.1	6.8	18.2	17.9	18.7	18.3	16.8	16.6	17.2	16.9

In the beginning of April (08.04 -11.04) the hybrids enter the budding phase. Depending on the year of study, PT234 hybrid reaches the earliest this phase (10.04; 09.04; 08.04), followed by PR44W29 and PT271 hybrids (10.04; 10.04; 9.04), and PT225 hybrid at the latest (11.04; 11.04; 10.04).

Of the three years of the experiment, the earliest phase of mass flowering occurred in the third year - 2020, and depending on the studied hybrids - PT234 (23.04 - 25.04), followed by hybrids PR44W29 (25.04 – 26.04); PT271 (25.04 – 27.04), and PT225 (26.04 – 28.04).

Of the tested hybrids, the longest vegetation period was reported for PT225 from 212 to 221 days, while the shortest - for PT234 from 209 to 218 days.

The structural analysis of the plants in the flowering phase during the years of the experiment is presented in Table 2.

The height of the plants of the tested hybrids on average for the study period varied from 139 to 142 cm.

In the three years of study, the highest plants were registered for PT234 hybrid (from 140 to 144 cm) followed by the hybrids PR44W29 (from 138 to 143 cm), PT225 (from 137 to 142 cm), and PT271 (from 135 to 143 cm).

The number of branches per plant in 2020 is higher than in 2018 and 2019.

In 2020, the number of branches varies from 7.0 for the PT225 hybrid to 7.4 for the PT234.

The average for the study period the largest number of branches (7.3 pieces) is registered for PT234 hybrid, and the smallest – for PT271 (6.8 pieces).

With regards to the indicator number of leaves per plant, higher values were reported in 2020 (from 18.7 to 19.1 pieces) compared to 2018 (from 18.2 to 18.9 pieces), and in 2019 (from 17.9 to 18.8 pieces).

On average for the study period, the number of leaves was highest for PT234 hybrid (18.9 pieces), and the lowest - for PT271 hybrid (18.3 pieces).

The thickness of the stems during the three years of study in different hybrids varies within small limits.

Both on average for the period and in the three separate years, the highest values of the structural elements are reported for PT234 hybrid, which also affects the size of the yield.

The morphological analysis of the plants of the cultivated hybrids shows that the highest relative share in the individual parts of the plant belongs to the stems (from 56.6 to 57.5%) followed by the leaves (from 35.2 to 36.0%), and blossoms (7.2 to 7.4%) (Table 3).

The highest percentage of the total mass of the plant for PT225 hybrid consists of the leaves (36.0%) followed by the hybrids PR44W29 (35.9%), and PT234 (35.7%), while the smallest percentage is reported for PT271 hybrid (35. 2%).

The relative share of the blossoms in the four hybrids is almost the same (7.2 – 7.4%).

The ratio between the individual organs of plants in the cultivation of rapeseed for green fodder is most appropriate when the percentage of stems is lowest, and the leaves and flowers - the highest.

Of the tested hybrids, PT225 hybrid best meets these requirements, the morphological analysis of which is closest to the above requirements, and appears as the most suitable for growing for green mass.

With slightly lower values, the other hybrids are also very suitable for growing green fodder.

The results of the experiment show that, depending on the meteorological conditions, the yield of green mass obtained from the cultivated hybrids changes in the years of study.

The more favourable combination of climatic factors and the better distribution of precipitation in 2020 created conditions for obtaining higher green mass yields (from 68 310 kg/ha to 69 810 kg/ha) compared to 2018 (67 600 kg/ha to 69 230 kg/ha), and in 2019 (67 240 kg/ha to 68 720 kg/ha) (Table 4).

On average for the study period, the highest green mass yield was reported for PT234 hybrid (69 250 kg/ha), and the lowest for PT271 hybrid (67 740 kg/ha).

From the mathematical processing performed in terms of green mass yield, the differences between PT234 and all hybrids at CD5%, are mathematically proven.

Table 3. Morphological analysis of plants on average for the period of growing in the flowering phase

Hybrids	Weight of one plant (g)	%	Weight of the stems of a plant (g)	%	Leaf weight of a plant (g)	%	Weight of flowers of a plant (g)	%
PT225	159.4	100	90.2	56.6	57.4	36.0	11.8	7.4
PT234	162.8	100	93.0	57.1	58.1	35.7	11.7	7.2
PR44W29	160.0	100	90.9	56.8	57.5	35.9	11.6	7.3
PT271	158.3	100	91.0	57.5	55.8	35.2	11.5	7.3

Table 4. Green mass yield kg/ha

Hybrids	Years			
	2018	2019	2020	Average
PT225	67850	67500	68310	67890
PT234	69230	68720	69810	69250
PR44W29	68470	67950	68940	68450
PT271	67600	67240	68390	67740
GD 5%	710.51	690.10	800.33	

The data on the chemical composition show that there are small differences between the tested hybrids in terms of the content of crude protein in the dry matter of rapeseed (Table 5).

Table 5. Chemical analysis of the gre§en mass, average for two years

Hybrids	Absolute dry matter %	Crude protein %	Crude fat %	Crude fibre %
PT225	87.4	17.2	3.45	30.93
PT234	86.8	17.0	3.58	31.27
PR44W29	87.0	17.0	3.53	31.45
PT271	86.9	16.8	3.50	31.50

The values of crude protein on average for the study period in the tested hybrids vary from 16. 8 to 17.2%, which is due to differences in climatic conditions, and the percentage of individual plant parts (stems, leaves, blossoms). The higher relative share of leaves in PT225 hybrid is also the reason for the higher crude protein content (17.2%).

The other three hybrids have lower crude protein values compared to the PT225 hybrid, but the differences between them are insignificant.

Regarding the content of crude fat in the dry matter, there are no significant differences between the individual hybrids. The values range from 3.45-3.58%.

The content of crude fibre in the dry matter between the individual hybrids varies from 30.93 to 31.50%.

The higher percentage of stems in the aboveground biomass of PT271 hybrid creates a prerequisite for the highest fibre content (31.50%).

This confirms the trend that plants with a higher percentage of leaves have a higher protein content, and these with higher percentage of stems - a higher crude fibre content.

Therefore, in the case of PT225 hybrid, with the lowest percentage of stems, the lowest fibre content is reported (30.93%).

Summarizing the data on the chemical composition of the green mass, we come to the conclusion that hybrid PT225 is characterized by the highest quality of green fodder, due to having the highest content of crude protein and the lowest content of crude fibre.

The green mass obtained from the other hybrids also meets all the indicators for very high quality fodder.

CONCLUSIONS

The duration of the vegetation period in 2017-2018 is from 209 to 212 days, in 2018-2019 - from 218 to 221 days, and in 2019-2020 - from 210 to 213 days.

The highest values of the structural elements both in the three separate years and on average for the period are reported for PT234 hybrid.

From the morphological analysis of the plants of the cultivated hybrids it is observed that the highest relative share in the individual parts of the plant belongs to the stems (from 56.6 to 57.5%), followed by the leaves (from 35.3 to 36.1%), and the blossoms (from 7.1 to 7.4%).

The best ratio of the individual parts of the plants is reported for PT225 hybrid.

During the two years of the experiment and on average for the study period, the highest green mass yield was obtained by PT234 hybrid (69270 kg/ha).

Highest crude protein content and lowest crude fibre content are reported for PT225 hybrid.

All four hybrids tested are high yielding and of high quality, and can be grown for green fodder.

REFERENCES

Delchev, L. (1988). Sravnitelno rzpitvane na tntrodutsirani sortoive zimna rapitsa zazelenamasa pri polivni uslovia. *Rastenievadni nauki* br 1, 62-66.

Jeromela, M., Mikić, A., Marinković, R., Mihailović, V., Milić, D. (2010). Green forage yield components in winter oilseed rape (*Brassica napus* L. var. *napus*). *Cruciferae Newsletter*, *29*. 6–7.

Ivanova R. (2008). Rapeseed, a crop of the future. Videnov and Son Publishing House.

Ivanova, R., Todorov, Zh., Delibaltova, V. (2009). Quality of green fodder obtained by growing different varieties and hybrids of rapeseed in the region of Plovdiv. *Agricultural Sciences*, *I*(2), 25–29.

Ivanova, R. (2012). Rapeseed, a crop of the present and future. Videnov and Son Publishing House.

Mikić, A., Marjanović-Jeromela, A., Mihailović, V., Marinković, R., Pataki, I., Katanski, S. (2010). Green forage yield components in spring oilseed rape *(Brassica napus L. var. napus*). *Cruciferae Newsletter*, *29*. 8–9.

Ntkiforov, O. (2004). Raps - tsennaya i perspektivnaya kulytura. *Selyskohozyaystvennyiewesti*, Ns 2, 15-16.

Shpaara, D. (2012). Raps i surepitsa: vyirashtivanie' uborka, rspo |yzovanie. Uchebno-pra|ticheskoerukovodstva, Moskva.

Todorov, Zh. (2012). Growth, development and productive capacity study on rapeseed hybrids grown for green forage in South Bulgaria. *Agrarian Sciences*, *4*(11), 131–134.