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PRODUCTIVE CAPACITY OF RAPESEED HYBRIDS GROWN IN THE CONDITIONS OF CENTRAL SOUTH BULGARIA

Zhivko TODOROV

Agricultural University of Plovdiv, 12 Mendeleev Blvd, Plovdiv, Bulgaria

Corresponding author email: jivko99999@abv.bg

Abstract

This study was conducted in the course of three years (2017-2020) in the EEIB (Educational and Experimental Implementation Base) of the Department of Plant-growing at the Agricultural University of Plovdiv. The experiment was implemented according to the block method in 4 repetitions with the size of the experimental plot 20 m^2, on a meadow lightly solonetz soil. Subject of the experiment are the hybrids PT234, PT225, PT271 and PT264. The purpose of the study is to determine their productivity when grown in the conditions of Central South Bulgaria. Regardless of the different weather conditions during the years of the experiment, the highest seed yield was reported for hybrid PT 234.

Key words*: rapeseed, hybrids, yield.*

INTRODUCTION

Rapeseed is a plant that in recent years has taken an important place among crops cultivated in our country. The range of its applications is various, including from the food industry to the use in biofuels. Thanks to its deep root system, it improves the structure of soil and increases its water permeability. Therefore, intensive selection activity is being done in a number of countries in the world with the purpose of creating new high-yielding and high-quality hybrids (without erucic acid and low content of glucosinolates) (Zheng et al., 2022; Seyis et al., 2006; Nita et al., 2022; Bopp et al., 2021; Zhang et al., 2022). The lack of selection activity in our country necessitates testing and implementation in practice of foreign hybrids and varieties. For this reason, the goal of this work is to test several introduced rapeseed hybrids, establish their phenological development, structural elements, productivity and mass of 1000 seeds in the conditions of Central South Bulgaria with a recommendation for cultivating the most suitable of them.

MATERIALS AND METHODS

The study was conducted in the area of the Training, Experimental and Implementation Unit of the Department of Plant growing in the Agricultural University of Plovdiv during the period 2017-2020. The experiment was set up according to the block method in 4 repetitions with the size of the experimental plot 20 m^2. The hybrids included in the experiment are PT234, PT225, PT271 and PT264. Wheat was used as a precursor, and rapeseed was grown according to the adopted technology.

The following indicators are recorded: the phases of development during the vegetation of the crop, plant height (cm), number of branches per plant (pcs), number of fruits and seeds per plant (pcs), fruit length (cm), weight of seeds per plant (g), seed yield per hectare (t) mass per 1000 seeds (g) . Processing of the mathematical data was done by variance analysis with the Biostat software package, version 5.1 (Penchev, 1998).

RESULTS AND DISCUSSIONS

The quantity of precipitation during the years of the experiment varied from 600.5 mm in 2017-2018 to 474.4 mm in 2018-2019 (Figure. 2). The quantity of precipitation fallen in all three years is higher compared to that of the multi-year period (419 mm).

The most favourable for rapeseed development is 2018-2019, which is characterized by the best combination of temperature and moisture

during the critical periods of plant development. (Figures 1 and 2).

Negative temperatures during the years of the study were recorded in the months of March (-10.6°C for 2017-2018 and February -11.2°C in 2018-2019 and the month of January -10.5°C in 2019-2020) (Figure 3).

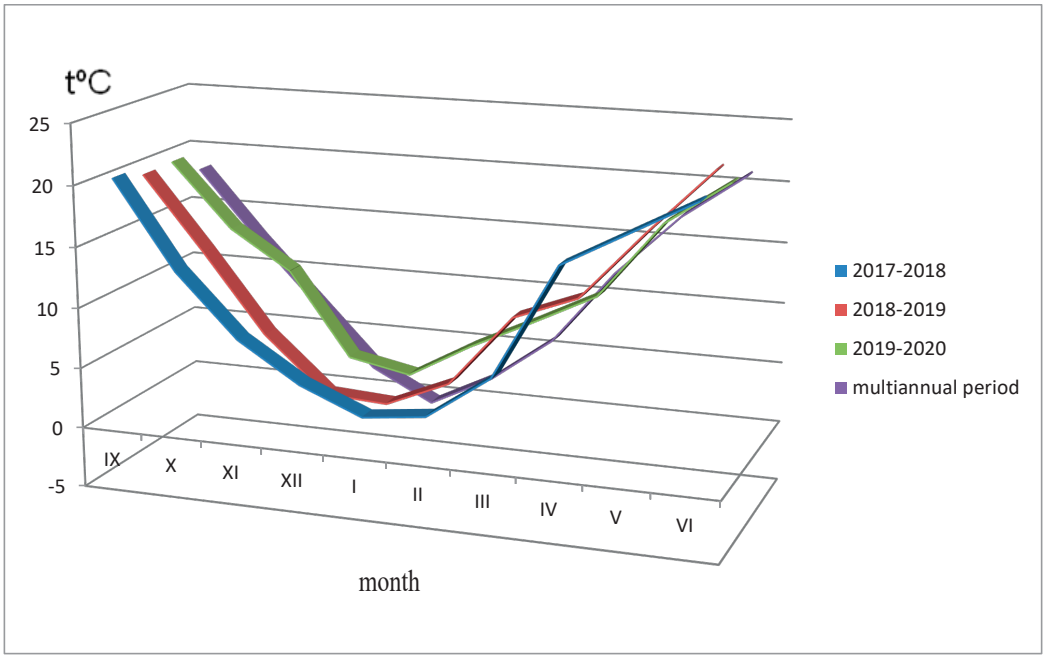

Figure 1. Month mean temperature for the experimental period, °C

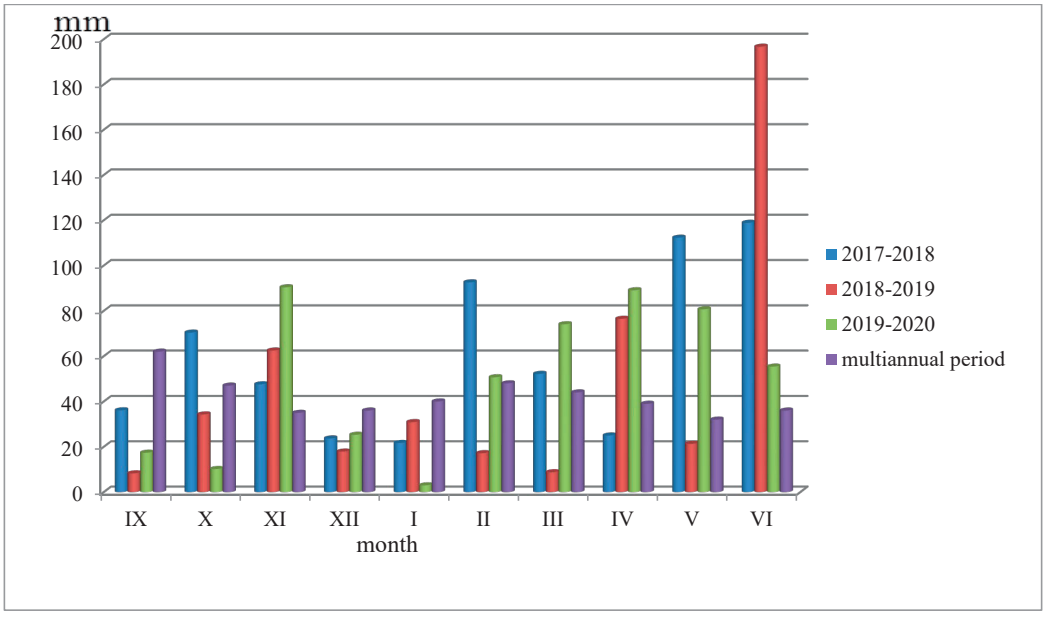

Figure 2. Quantity of rainfalls, mm

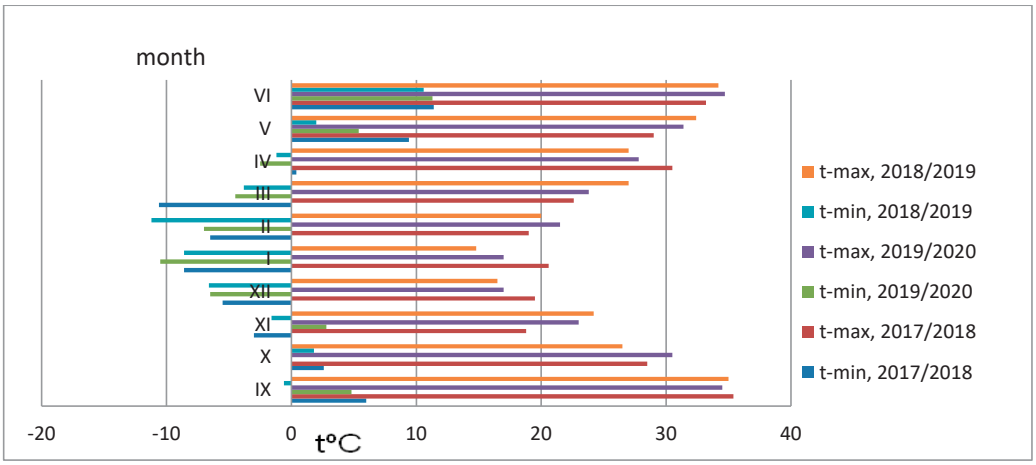

Figure 3. Absolute minimum and maximum air temperatures, °C

The phenological observations show that, due to the weather conditions and the specifics in the development of the tested hybrids, the development phases occur at different times (Table 1).

A major factor for the development of rapeseed, especially during germination and the first phase of the development of the crop is moisture content.

That is why, the precipitation that fell during the germination period (36.1mm - 2017; 8.3 mm - 2018; 17.4 mm - 2019), created conditions for the plants in 2018 to sprout the earliest (20.09), followed by 2019 (27.09) and the latest - in 2017 at 28.09.

About a month after sprouting, all tested hybrids reach the 6th-8th leaf stage.

Depending on the year of the experiment, the tested hybrids reach this phase from 26.10 to 30.10.

When temperatures drop in December (-5.5°C - 2017; - 6.6°C - 2018; -6.6°C - 2019), rapeseed suspends its vegetation.

This period in the first year of study occurred on 12.12, in the second - on 9.12, and the third - on 8.12.

The increase in temperatures in all three study years in the beginning of March led to the resumption of vegetation (the time from 7.03 to 10.03).

The next stage which is stem formation was reported 1 to 3 days earlier in 2020 compared to 2018. In 2019 this stage occurred up to 1 day earlier than in 2018 and 1 to 2 days later than in 2020.

During the three years of the experiment, the hybrids entered the stage of stem formation as follows: PT264 (26.03; 25.03; 23.03), PT271 (25.03; 25.03; 24.03), PT234 (26.03; 25.03; 24.03) and PT225 (27.03; 27.03; 25.03).

The plants of all tested specimen entered the budding stage, from 8.04 to 11.04.

Hybrid PT234 entered the earliest in this stage (10.04; 9.04; 8.04), and the latest - PT 225 (11.04; 11.04; 10.04).

Hybrid PT234 (10.04; 9.04; 8.04) entered this stage at the earliest, and hybrid PT 225 (11.04; 11.04; 10.04) at the latest.

During the period of the experiment, the large-scale flowering stage occurred in the third ten days of April. For individual hybrids, this stage was recorded on 26.04; 25.04; 23.04 for PT234 hybrid, on 26.04; 27.04; 25.04 for PT271 hybrid, on 26.04; 26.04; 24.04 for PT264 hybrid and on 27.04; 28.04; 26.04 for PT225 hybrid.

Full maturity stage occurred a few days later in 2018 compared to the other two years.

PT234 hybrid (29.06; 25.06; 24.06) entered this stage at the earliest, and PT 225 hybrid - at the latest (30.06; 29.06; 27.06).

The vegetation period of the tested hybrids varies from 272 to 283 days, the shortest being for PT234 hybrid - from 272 to 279 days, and the longest is for PT225 hybrid - from 275 to 283 days.

Table 1. Phenological observation

Phenological observation	Hybrids											
	PT234			PT 225			PT271			PT264		
	Years											
	2017 2018	2018 2019	2019 2020	2017 2018	2018 2019	2019 2020	2017 2018	2018 2019	2019 2020	2017 2018	2018 2019	2019 2020
Sowing	5.09	3.09	5.09	5.09	3.09	5.09	5.09	3.09	5.09	5.09	3.09	5.09
Prouing	28.09	20.09	27.09	28.09	20.09	27.09	28.09	20.09	27.09	28.09	20.09	27.09
6st-8th leaf	29.10	26.10	29.10	30.10	28.10	30.10	29.10	27.10	29.10	30.10	27.10	30.10
Finish vegetation	12.12	9.12	8.12	12.12	9.12	8.12	12.12	9.12	8.12	12.12	9.12	8.12
Beginning vegetation	10.03	7.03	9.03	10.03	7.03	9.03	10.03	7.03	9.03	10.03	7.03	9.03
Stem development	26.03	25.03	24.03	27.03	27.03	25.03	25.03	25.03	24.03	26.03	25.03	23.03
Bud stage	10.04	9.04	8.04	11.04	11.04	10.04	10.04	10.04	9.04	10.04	10.04	9.04
Beginning of flowering - 10%	18.04	17.04	15.04	19.04	20.04	17.04	17.04	18.04	16.04	19.04	17.04	16.04
Full flowering - 75%	26.04	25.04	23.04	27.04	28.04	26.04	26.04	27.04	25.04	26.04	26.04	24.04
Wax ripeness	14.06	13.06	11.06	16.06	16.06	14.06	15.06	15.06	13.06	14.06	13.06	11.06
Full maturity	29.06	25.06	24.06	30.06	29.06	27.06	30.06	28.06	26.06	30.06	26.06	25.06
Vegetation period, days	274	279	272	275	283	275	274	282	274	275	280	273

The indicators that have a direct impact on seed yield are presented in Tables 2 and 3.
They change over the cultivating years due to the weather conditions.
On average over the study period, the plant height of the tested hybrids ranged from 156.8 to 167.1 cm.
As a result of the more favourable combination of climatic factors in 2019, the height of the plants at the end of the growing season had higher values in all tested hybrids, except for PT 225 hybrid.
The reason for the formation of lower plants in 2019-2020 is the irregular distribution of precipitation in the critical periods of rapeseed development.
The greatest height during the term of the experiment was recorded for PT 234 hybrid (168.3 cm; 169.6 cm; 163.5 cm), and the lowest, except for the first year, for PT 264 hybrid (157.3 cm; 157.4 cm; 155.9 cm).
Over the years of the study, the number of branches in all tested hybrids was the highest in 2019, except for PT225 hybrid, where a higher number of branches was recorded in 2018. Of the hybrids tested, PT 234 had the highest values, from 8.2 to 8.4 pieces, and with the lowest, PT 264 hybrid - from 7.5 to 7.7 pieces.
The highest number of branches on average for the study period was recorded for PT234 hybrid (8.3 pieces), and the least for hybrids PT271 and PT264 (7.6 pieces).
The more favourable effect of climatic factors in 2019 is a precondition for the formation of a larger number of fruits (from 214.9 to 229.7 pieces) per plant compared to other years (from 203.0 to 221,9 pieces).
On average for the study period, the number of fruits was the highest for PT 234 hybrid (224.2 pieces) and the least in PT 264 hybrid (210.9 pieces).
The length of the fruits during the years of study and averagely over the period varied within small limits.
The highest values for this indicator were reported for PT234 hybrid (from 8.0 to 8.4 cm).
For the rest of the hybrids, the length of the fruits on average during the experiment ranged from 7.8 cm to 7.9 cm.
The number of seeds in one fruit varies within a limited range. On average for the study period, the highest values were recorded for PT 234 hybrid (27.8 pieces), and for the other hybrids the number of seeds was between 26.3 and 27.2 pieces.
Fruit and seed weight are the structural elements that have the strongest influence on the seed yield of a plant. Higher values of these indicators in a combination with the climatic factors in the period of formation - filling and ripening of the seeds were reported in 2019.
The highest values of these indicators in 2019 were reported for hybrid PT 234 (26.9 g) and the lowest for hybrid PT 264 (25.8 g) regarding fruit weight, while regarding seed weight per plant - from 14.6 for hybrids PT 264, PT271 - up to 15.4 g for PT 234 hybrid.
In the other two years, the values of these indicators were from 25.5 g to 26.5 g with regards to fruit weight and from 14.4 g to 15.2 g with regards to seed weight.
On average for the study period, the weight of the pods had the highest values for PT 271 hybrid (11.4 g) and the lowest in PT264 hybrid (11.2 g).
Both in individual years and on average for the period, the weight of the pods in the studied hybrids was almost the same.
Structural elements that have the greatest influence on seed yield have the highest values in PT 234 hybrid.
The data in Table 4 show the seed yield obtained during the years of the experiment depending on the climatic conditions and the studied hybrids.
Higher yields in all tested hybrid variants were reported in 2019, except for PT225 hybrid.
A precondition for this is the better combination and distribution of meteorological factors this year.
The highest seed yield in the first year of study was obtained from PT234 hybrid (3.829 t/ha) followed by PT225 (3.813 t/ha), PT264 (3.712 t/ha) and PT 271 (3.549 t/ha).
In the second and third years of the study, the highest yield was obtained from hybrid PT234 (3.917 and 3.557 t/ha), and the lowest from PT264 (3.759; 3.354 t/ha).
For the hybrids subject of this study, on average during the test period, the highest seed yield was obtained from hybrid PT234 (3.788 t/ha), followed by PT225 (3.656 t/ha), PT264 (3.608 t/ha), and lowest - from PT 271 (3.574 t/ha).

Table 2. Structural analysis of yield elements

Hybrids	Height plants (cm)				Number of branches in a single plant (pcs)				Number of fruits in a single plant (pcs)				Fruit length (cm)			
	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
PT234	168.3	169.6	163.5	167.1	8.2	8.4	8.2	8.3	221.9	229.7	220.9	224.2	8.1	8.4	8.0	8.2
PT225	159.8	158.0	156.7	158.2	8.0	7.9	7.4	7.8	217.8	215.3	205.3	212.8	8.0	7.9	7.8	7.9
PT271	156.9	157.6	156.0	156.8	7.6	7.7	7.6	7.6	211.2	214.9	207.7	211.3	7.9	7.9	7.9	7.9
PT264	157.3	157.4	155.9	156.9	7.6	7.7	7.5	7.6	213.4	216.4	203.0	210.9	7.9	7.8	7.6	7.8

Table 3. Structural analysis of yield elements

Hybrids	Number of seeds in one fruit (pcs)				Weight of the fruit in a single plant (g)				Weight of the seeds in a single plant (g)				Weight of pods in a single plant (g)			
	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
PT234	27.8	28.0	27.5	27.8	26.5	26.9	26.0	26.5	15.2	15.4	15.0	15.2	11.3	11.5	11.0	11.3
PT225	27.2	26.8	26.5	26.8	26.1	26.1	25.7	26.0	14.8	14.7	14.5	14.7	11.3	11.4	11.1	11.3
PT271	26.6	26.7	26.6	26.6	25.9	26.0	25.9	25.9	14.5	14.6	14.5	14.5	11.4	11.4	11.4	11.4
PT264	26.7	26.7	26.3	26.6	25.8	25.8	25.5	25.7	14.6	14.6	14.4	14.5	11.2	11.2	11.1	11.2

Table 4. Yield of seeds t/ha

	2018	2019	2020	Average
PT234	3.829	3.917	3.557	3.788
PT225	3.813	3.772	3.383	3.656
PT 271	3.549	3.740	3.432	3.574
PT264	3.712	3.759	3.354	3.608
GD 5%	0.0624	0.020	0.0610	

From the mathematical processing of seed yield by year, provenance at CD 5% was found between hybrid PT234 and all other hybrids except hybrid PT 225 in the first year.

The mass of 1000 seeds gives an idea of the physical properties of the seeds and is directly related to obtaining high yields (Table 5).

Agro-climatic conditions, agricultural techniques and the difference between hybrids influence this indicator.

The highest mass per 1000 seeds during the years of study was recorded in 2019, and the lowest - in 2020.

On average for the growing period, the highest mass per 1000 seeds was reported for PT234 hybrid (5.17 g).

Over the years of study, on the basis of the mathematical processing done, evidence regarding this indicator at CD 5% has been established between hybrid PT234 and the other specimen.

Table 5. Mass of 1000 seeds

Hybrids	Mass of 1000 seeds (g)			
	2018	2019	2020	Average
PT234	5.17	5.20	5.15	5.17
PT225	5.12	5.11	5.07	5.10
PT 271	5.00	5.01	5.00	5.00
PT264	5.01	5.02	4.96	5.00
GD 5%	0.04	0.07	0.05	

CONCLUSIONS

During the years of the experiment, the vegetation period for the tested hybrids varied from 272 to 283 days.

The structural elements of yield for all hybrids have the highest values in 2018-2019. The only exception is hybrid PT225, where the highest values were recorded in the first year.

During the three years of study, the highest values of all structural elements were recorded for PT234 hybrid.

The obtained seed yield in 2018-2019 is higher compared to the other two years. Only for PT225 hybrid higher yield was reported in the first year.

In all three years of the study and averagely over the period, the highest seed yield was obtained from PT234 hybrid.

The mass of 1000 seeds in the three years and averagely over the period was highest for PT234 hybrid (5.17; 5.20; 5.15 g.).

REFERENCES

Bopp, V., Kurachenko, N., Khalinskiy, A., Churakov, A., Stupnitskiy, D. (2021). Seed productivity of rapeseed hybrid. *Bulletin of NSAU (Novosibirsk State Agrarian University), 4*. 6–16.

Nita, S., Nita, L., Sirb, N., Copcea A., Mateoc-Sirb T., MihutI C., Mocanu N. (2022). The agro-productive efficiency of some rapeseed hybrids in the pedoclimatic conditions in the Gătaia Plain, Timiș County, Romania. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 22*(4), 471–476.

Penchev (1998). Biostat software package, version 5.1.

Seyis, F., Friedt, W., Lühs, W. (2006). Yield of *Brassica napus* L. hybrids developed using resynthesized rapeseed material sown at different locations. *Field Crops Research., 96*(1), 176–180.

Zhang, J., Zhang, S., Li, J., Ch. Cai, Ch., Gu, W., Cheng, X., H. Wang, H., Xue, X. (2022). Effects of Different Pollination Methods on Oilseed Rape (*Brassica napus*) Plant Growth Traits and Rapeseed Yields. *Plants, 11*(13). 1677.

Zheng, M., Terzaghi, W., H. Wang H., Hua W. (2022). Integrated strategies for increasing rapeseed yield. *Trends in Plant Science, 27*(8), 742–745.