COMPARATIVE ANALYSIS REGARDING QUALITY INDICATORS FOR RAPESEED GENOTYPES - PERLA TYPE AND MAXIMUS PT225 HYBRID, IN WESTERN ROMANIA

O. C. UNGUREANU*[1], Elena UNGUREANU[2], Viviane Beatrice BOTA*[1,3,4], I. O. STANA[1], Violeta TURCUȘ[1,4]

[1] „Vasile Goldiș" Western University of Arad, Faculty of Medicine, Biology Department, Arad, Romania
[2] „Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iași, Romania
[3] „Alexandru Ioan Cuza" University of Iași, Faculty of Biology, Doctoral School of Biology, Iași, Romania
[4] Institutul Național de Cercetări Economice „Costin C. Kirițescu" al Academiei Române/ Centrul de Economie Montană (CE-MONT), Vatra Dornei, România
Corresponding authors: ovidiu.c.ungureanu@gmail.com, viviane.beatrice@gmail.com

Abstract. *Considering the necessity of complex preparation and efficient biomass valorization, as well as the high utility potential of rapeseed cultures, for this study we focused on quality indicators for 2 rapeseed genotypes. The purpose was to find optimal solutions to extend the rapeseed crops and increase the production capacity for this source of rich vegetal fats and proteins. The monofactorial experiment included 2 hybrid types of autumn rapeseed, cultivated in optimal technological conditions, in 4 repetitions. Experimental variants used are V1 – Maximus PT225, and V2 – Perla autumn rapeseed genotypes. We evaluated the plant's size, the height of the insertion point for the first silique, number of siliquae, Weight of 1000 seeds, seed production, as well as protein, fat, starch, and glucosinolates content, in percentage. Maximus PT225 hybrid showed better results in terms of seed production, seed's protein content, and seed's fat content compared to Perla type, as well as higher profits. The only aspect where Perla type leaded was in regards to the starch content. Glucosinolates content of the two variants taken into study was between the safe limits for both human and animal consumption. The results show that these types of autumn Rapeseed can be successfully cultivated in Romania's Western area, in optimal conditions, being well adapted to the local pedo-climatic conditions.*

Keywords: *Rapeseed, genotype, hybrid, Romania.*

INTRODUCTION

The importance of rapeseed (*Brassica napus* L.) has increased considerably in the present because it provides the prime material for oil production, which is an unconventional alternative to fossil fuel sources, as well as the production of superior quality oils for the human diet and industrial sectors.

It is the 3rd biggest source of vegetal oil in the world, the European Union being responsible for almost 1/3 of the world production for rapeseed, meaning 60 million tones per year, Romania producing approximately 1610 tones in 2018 [3].

For optimal production, specialists recommend average temperatures between 7 - 10°C, chernozem soils, or red-brown soils, clay, sandy, humus-rich soils with a good supply of nutrients, together with a good amount of precipitations (favorable areas are those with 450-650 mm annual precipitations), and covered with a sufficiently thick snow cover during winter. Rapeseed can be cultivated on the same land with 3 years break between crops, being a good precursor for the majority of plants [2]. To obtain a stable, consistent yield, it is recommended to distribute the plants uniformly across a unit area, as density is an essential factor in the yield of individual plants and in the yield's composition [5].

Regarding the soil reaction, rapeseed crops are less resistant to acidity, preferring soils that are weakly acidic to neutral or even weakly basic. A rapeseed crop consumes a large quantity of Phosphorus, in some cases, it is necessary to apply fertilizers before the plowing or before the sowing. Studies show that 1000 kg of *B. napus* seeds need 50-60 kg N, 30-60 kg P_2O_5, 40-50 kg K_2O, 50-60 kg Ca, and 20-30 kg S, along with an adequate quantity of microelements [9].

The above-mentioned conditions are encountered in Banat and Crișana Plains, in the center of Transylvania, East of Moldova, in silvosteppes from Southern Romania, and in the Southern area of Siret Meadow [2,9].

Rapeseed is an important prime material for the biodiesel industry, rapeseed oil being a vegetal fuel much cheaper than diesel, biodegradable, thus helping in reducing pollution, having no negative impact on the environment [10]. Biodiesel is a fuel that can be used with all last generation Diesel motors and is an ecological alternative to diesel fuel [4,11].

Rapeseed oil is used in the textile industry, leather industry, for plastic materials, varnishes, paints, inks, detergents, in the printing industry, for lighting or lubricating, painting oil, candles, for the production of antidust agents, as an adjuvant for pesticides, hydraulic fluid, etc. [2,8].

The plant contains proteins, carbon hydrates, minerals (Ca, Fe, P, K, Na), cellulose, sugars, fats, mucilage, and vitamins (A, B1, B2, niacin, C, β-carotene). The seed composition offers the oil skin-healing properties, disinfectant, purifying, diuretic, emollient, expectorant, fortifying, nutritive, antioxidant, and cellular regeneration properties. The seeds contain 42-48% oil, which is rich in ω3 fatty acids (α-linoleic acid precursor to ω3), and vitamin E, and is used in the human diet, or for the preparation of margarine, being considered a healthy food [14].

The rapeseed remnants that result from seed pressing have a high fodder value, being a good source of proteins (38-42%), carbohydrates, and mineral salts for animals. The plant can be used as green forage in late autumn, and early spring, from 100 kg of seeds can be obtained 30-35 kg of oil and 50-55 kg of groats. Rapeseed straws can be used in the construction materials industry. Rapeseed is harvested early, the reason for which it makes a good precursor crop for wheat and autumn barley, and is a very good early honey plant, assuring approximately 50 kg of honey per hectare. The last cultivation technologies in the field, along with the new hybrids, allow the successful cultivation of rapeseed even in the climatic conditions of Romania [2,9].

The hybrids are preferred to other rapeseed types, because they have a better sturdiness at the vegetation start, higher resistance to drought, higher tolerance to abiotic stress factors, and uses nutrients more efficiently. In stress conditions, the hybrids are more robust, with a better developed radicular system, higher resistance during winter, and better adaptation to environmental factors. They can be cultivated in various climatic conditions, respond better to treatments, exceeding the performance of other rapeseed types [1,6,12]. From an economic perspective, it is very important that for sowing are used fewer seeds, by 30-50% less than other rapeseed types (3,0 – 4,0 kg/ha), and the ripening is more uniform [2,9,7].

In the 2018 Romanian ISTIS official catalog are registered about 20 types and 90 hybrids of rapeseed. Autumn rapeseed is preferred, being perfectly adapted to the climate conditions in Romania. The most used hybrids are Dinasty, Sitro, and Exocet, with average productions of 4,4 tons/ha, with 20-23% more than other cultivated types

and hybrids. Other hybrids adapted to the climatic conditions from Romania are Exagone, Safran, Neptune, Karibik, Artist, Betty, Astrid, and Ilia [15,2,9].
Rapeseed crops are easy to maintain, with good yields in terms of production and profit.
Considering all these aspects, we performed a comparative study, regarding the morphological, biochemical, and productivity aspects between the autumn Perla rapeseed type, and the autumn rapeseed hybrid Maximus PT225, offered by PIONEER HI-BRED. Specialists recommend the hybrids because of their high productivity, and oil with a low content of glucosinolates, because they mature early, being possible to be sowed both in early and late seasons [16].

MATERIAL AND METHODS

For this study, we used autumn rapeseed seeds, Perla type, and Maximus PT225 hybrid (Fig. 1.), offered by PIONEER HI-BRED Romania, harvested in June 2020 (Table 1).

Table 1

Brassica napus seed characterstics for Perla type and Maximus PT225 hybrid

Parameters	Perla type	Maximus PT225 hybrid
Humidity (%)	9,9	9,8
Purity (%)	95	96
Germination (%)	91	92

Figure 1. Perla type rapeseed (left), and Maximus PT225 hybrid (right).

The precursor crop was wheat. The soil was analyzed and its characteristics are presented in table 2.

Table 2

Soil characteristics in the moment of sowing

Parameters	Value at sowing time (%)
Humidity	57,13
Dry mass	42,787
Ash	3,141
Volatiles	96,859
pH	6,12
C	53,81
N_t	0,92
C/N	58,48
$P(P_2O_5)$	0,24
$K(K_2O)$	0,21

Determination of ash contents was done using the calcination method, at 550°C, and the determination of humidity, and dry mass content, by the gravimetric method. Determination of organic carbon was done with the dry combustion method, using automatic analyzer LECO TruSpec CN. Phosphorus and Potassium content was determined with the Egner-Riehm method and total Nitrogen with Kjeldhal method. The volatile substances percentage was obtained by subtracting the ash mass percentage from 100 [13].

We analyzed the following morphological indicators: plant's size, insertion of the first silique, numbers of siliquae per plant, the weight of 1000 sees (MMB); quality indicators: humidity and purity of seeds (at the analysis time), seed protein content, seed fat/oil content, seed starch and glucosinolates content; and productivity/economic indicators: seed production (kg/ha), seed production value (lei/ha), and the profit obtained (euros/ha).

RESULTS AND DISCUSSIONS

The plant's size is the result of the interaction between the growth potential of the hybrid/type and the environmental conditions, along with the genotype's capacity for the valorization of phytotechnical factors applied. For the rapeseed variants taken into the study, the plant's size varied between 115 cm for Perla type and 155 cm for Maximus PT225 hybrid. having on average 135 cm (Check – Mean). Plant's size for Maximus PT225 was 40 cm higher than for Perla type (Fig. 2).

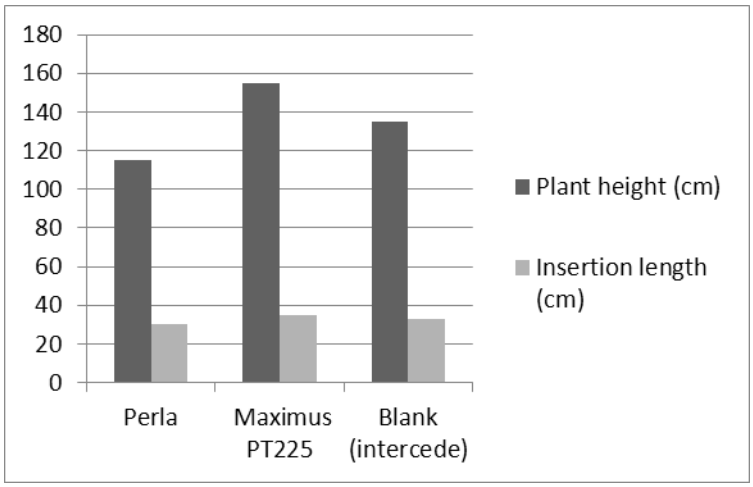

Figure 2. The influence of pedo-climatic conditions over the plant's size and insertion height for the first silique.

The number of siliquae on a plant was between 122 siliquae/plant for the Perla type, and 148 siliquae/plant for Maximus PT225 hybrid, the latter having 26 more fruits. The mean number for the 2 genotypes studied was 135 siliquae/plant (Fig. 3.).

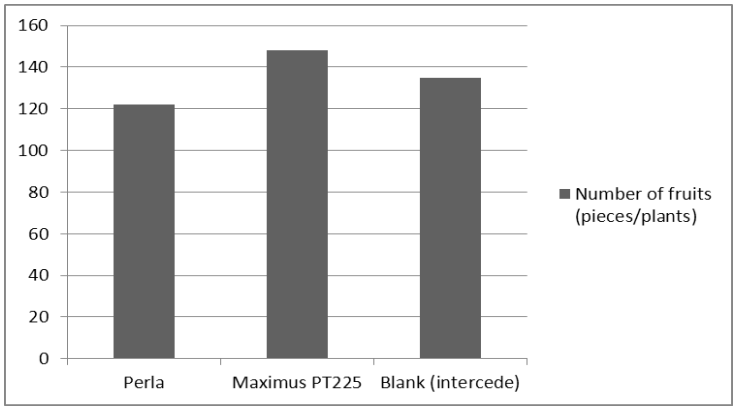

Figure 3. The influence of pedo-climatic conditions over the numbers of siliquae on a single plant.

The Weight of 1000 seeds was influenced by the genotype's characteristics, as well as by the growth and technological conditions, the value varying between 5,6 g for Maximus PT225, and 4,8 g for Perla type. The mean value for the two rapeseed variants was 5,2 g, the difference between the two genotypes being 0,8 g (Fig. 4.).

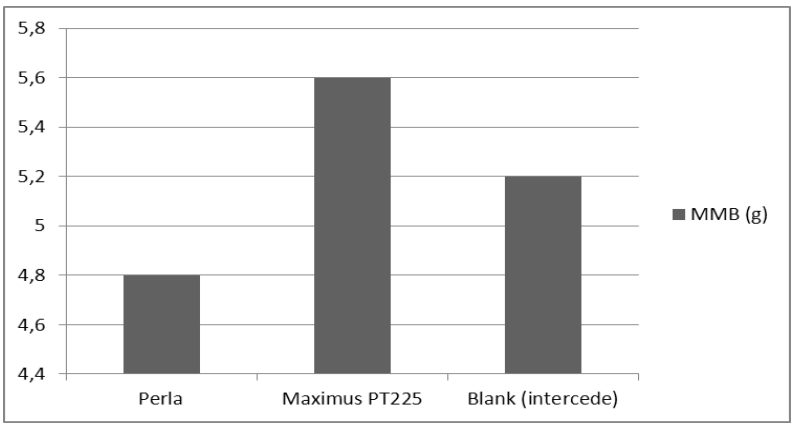

Figure 4. The influence of pedo-climatic conditions over the Weight of 1000 seeds.

The growth and development of the rapeseed plants were very good, with average seed production of 4315 kg/ha. Maximus PT225 hybrid had the biggest seed production, of 4560 kg/ha. The Perla type has adapted well to the local environmental conditions and had a seed production of 4070 kg/ha. The results for seed production for the 2 genotypes taken into study can be considered good, especially for the hybrid, which can be recommended for extension in the crops (Fig. 5.).

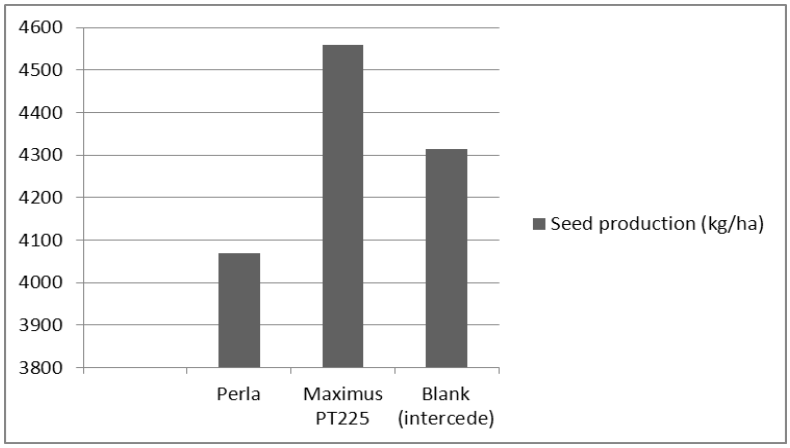

Figure 5. The influence of pedo-climatic conditions on seed productions.

The high content of proteins in seeds highlights the nutritional value of rapeseed foods, contributing to a prolonged state of fullness. The mean percentage of proteins in the seeds was determined with fast, non-destructive analysis methods, based on sensors, using the INFRATEC apparatus by Kjeltec. Results show values between 21,1% protein content for Perla seeds, and 24,5% for Maximus PT225 hybrid seeds. The average protein content was 22,8% (Fig. 6.).

Rapeseed is a plant from which the seeds are used for the extraction of cooking oil. The fat/oil content of seeds for the two genotypes was determined by the Soxhlet method (extraction with organic solvents), and the results showed values between 35,65% (Perla), and 42,45% (Maximus PT225), with a mean of 39,05% (Fig. 6.).

The glucosinolates are organic compounds that contain Sulf, which are commonly found in plants from the Cruciferous class, and when are present in high concentrations, they disturb the thyroid functions and cause gastric conditions to animals. Following the experimental data, the Maximus PT225 hybrid has the smallest concentration of glucosinolates (11,3 µmol/g), compared to the classic type (13,1µmol/g), making it the more preferable crop option.

Starch is the polysaccharide that is one of the most important energy sources for both animal and human organisms and is an essential source of carbohydrates. Once ingested with the food, the starch undergoes enzymatic hydrolysis in the presence of amylases and transforms into glucose. This one is further transported to the cells, where it is partially consumed for the energy necessities of the organism. The determination of starch content in seeds was done by hydrolysis in acid and warm medium, using the standard method of dosing of reduction carbohydrates [11].

Following the analysis, it was observed that Maximus PT225 seeds had 21,4% starch content, and Perla type seeds had 27,2% starch content. The mean value was 24,3% (Fig.6.).

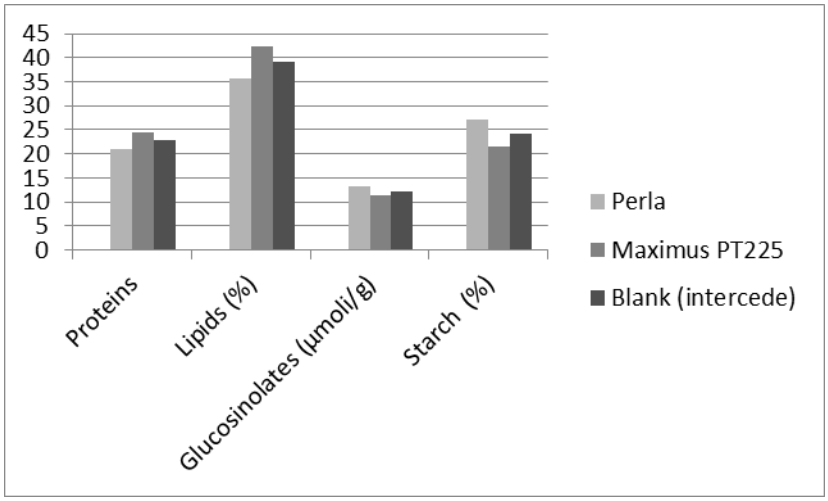

Figure 6. The content of proteins, lipids, starch, and glucosinolates for Maximus PT255 hybrid and Perla rapeseed type.

The efficiency of the two variants taken into the study is confirmed by the economic analysis of the behavior of the rapeseed hybrid, and rapeseed type respectively, in the growth and development conditions, considering the cultivation technology applied as well. The profits were 3580 lei/ha for Perla type and 4355 lei/ha for Maximus PT225 hybrid. The profits obtained highlight the value of the hybrid compared to the type. The average profit was 3967,5 lei/ha, meaning that the rapeseed crops were well adapted to the pedo-climatic conditions found in Western Romania (Fig. 7.).

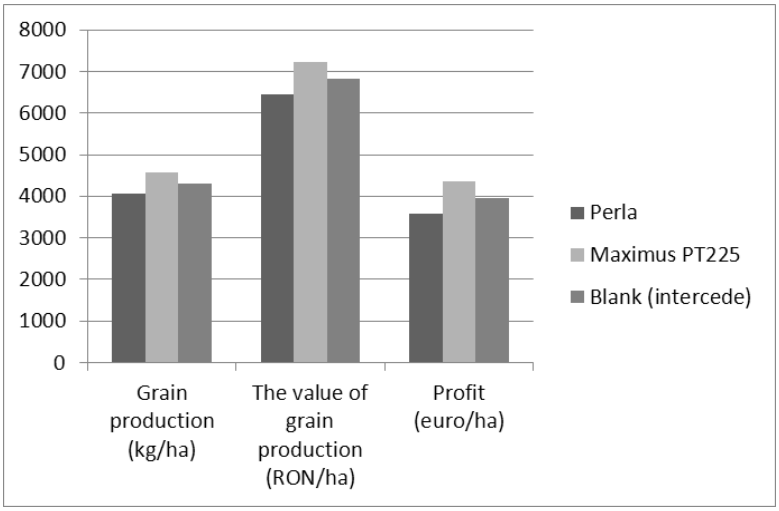

Figure 7. The influence of pedo-climatic conditions over the economic efficiency of studied rapeseed genotypes. 1 ton of rapeseed seed = 1582 RON, Production cost/ha = 2859 RON.

CONCLUSIONS

For this study, we cultivated two autumn rapeseed genotypes and made a comparative analysis of their morphological, biochemical, and production aspects. Maximus PT225 hybrid performed better than Perla type in almost all aspects. Regarding seed production, the hybrid had 4560 kg/ha. The average content of proteins (22,85), and fats (39,5%), was overall good for both genotypes, but Maximus PT225 exceed Perla type by 3,4% for proteins, and 6,8% for fats/oil. The seeds' average glucosinolates content was 12,2 µmol/g, meaning both genotypes can be safely used in the human diet and as animal fodder. The Maximus PT225 hybrid had smaller glucosinolates concentrations than the Perla rapeseed type. The starch content is the only aspect where the hybrid had 21,4%, with a 5,8% lower value than the Perla rapeseed type. The Maximus PT225 hybrid also offered higher profits, for an income of 7214 lei/ha, the profit was 4355 lei/ha, exceeding the profit obtained for the Perla type, which was 3580 lei/ha.

BIBLIOGRAPHY

AONO, M., WAKIYAMA, S., NAGATSU, M., KANEKO, Y., NISHIZAWA, T., NAKAJIMA, N., TAMAOKI, M., KUBO, A., SAJI, H., 2011 - Seeds of a possible natural hybrid between herbicide-resistant *Brassica napus* and *Brassica rapa* detected on a riverbank in Japan, p.31.

AXINTE, M., BORCEAN, I., ROMAN, G.,V., MUNTEAN, L., 2006 - Fitotehnie, Ed.Ion Ionescu de la Brad, Iaşi, p.84.

BAGHERI, H., 2013 - Review for growth and development processes in canola (*Brassica napus* L.), Global Journal of Medicinal Plant Research, p.23.

BERRY, P., M., SPINK, J., H., 2006 - A physiological analysis of rapeseed oil yields: past and future, The Journal of agricultural science, p.98.

DIEPENBROCK, W., 2000 – Yield analysis of winter oilseed rape (Brassica napus L.): a review, Field Crops Research, 67(1): 35-49.

GUO, Y., SHENG, C., LI, Z., COWLING, W., 2014 - Center of origin and centers of diversity in an ancient crop, *Brassica rapa* (turnip rape). J Hered, p.52.

HESS, L., MEIR, P., BINGHAM, I., J., 2015 - Comparative assessment of the sensitivity of rapeseed oil and wheat to limited water supply, Annals of Applied Biology, p.68.

KISHOR, K., 2003 - Plant Tissue Culture and Biotechnology: Emerging Trends, Ed. Universities, p.218.

MOGÂRZAN A., 2012 - Fitotehnie, Ed Ion Ionescu de la Brad, Iaşi, p.192.

NATH, U., K., KIM, H., T., KHATUN, K., PARK, J. I., KANG, K., K., NOU, I., I., 2016 – Modification of Fatty Acid Profiles of Rapeseed (Brassica napus L.) Oil for Using as Fodd, Industrial Feed-Stock and Biodiesel, Plant Breed Biotech, 4:123-134.

O'BRIEN, R., D., 2021 - Fats and Oils Formulating and Processing for Applications (3rd Edition), CRC Press.

THIYAM-HOLLÄNDER, U., MICHAEL ESKIN, N., A., MATTHÄUS, B., 2013 - Canola and Rapeseed: Production, Processing, Food Quality, and Nutrition, Ed. Taylor and Francis, p.221.

TRINCA, L., C., CAPRARU, A., M., 2012 - Biochimia alimentelor, Ed. Pim Iasi, p.206.

WHITE, M., 2016 - Rapeseed: Chemical Composition, Production and Health Benefits, Ed.Nova Science, p.102.

*** www.euralis.ro

*** www.pioneer.com/romania