DOI: 10.22620/agrisci.2022.32.009

PRECEDING CROP INFLUENCES ON THE DEVELOPMENT AND YIELDS OF THE WINTER OILSEED RAPE (*BRASSICA NAPUS* L.)

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Abstract

The evidence about the influence of the preceding crops on the oilseed rape growth and development is scarce. Therefore, a study in three vegetation seasons of the winter oilseed rape (2017/2018, 2018/2019, and 2019/2020) was conducted. The experiment was situated in the experimental field of the department of "Agriculture and herbology" at the Agricultural University of Plovdiv, Bulgaria. The experiment was conducted by the long plots method. The following crop rotations were under evaluation: 1. Winter wheat – winter oilseed rape; 2. Winter oilseed rape – winter oilseed rape; 3. Maize – winter oilseed rape. All evaluated parameters of the winter oilseed rape as plant height at the end of vegetation, number of primary branches and silique plant^{-1}, seed yield, absolute mass of 1000 seeds, hectoliter seed mass as well as seed oil content were influenced by the preceding crop. The highest results of the studied indicators for the rotation of winter wheat – winter oilseed rape were recorded. The lowest obtained results for the rotation maize – winter oilseed rape were found, and medium results were accomplished for the oilseed rape monoculture.

Keywords: winter oilseed rape, preceding crops, seed quality, yield

INTRODUCTION

For the last decades, the oilseed rape crop (*Brassica napus* L.) is considered one of the most important oilseed crop plants in the world. It is ranked as the second most important vegetable oil source around the globe (Brennan and Bolland, 2007). The growing importance of oilseed crops is also due to their use as a raw material for specific proteins, biofuels, industrial biopolymers, adhesives, surfactants, etc. (Wu and Muir 2008; Abbadi and Leckband, 2011; Vinnichek et al., 2019).

In Bulgaria, for 2020 the oilseed rape is grown on an area of 119.697 ha with a total production of 278.583 tons (MZH, 2021).

Crop rotation plays a major role concerning yields (Hilton et al., 2018). At a cropping system scale, the oilseed rape has beneficial effects on the yield and the nitrogen-use efficiency of the following cereal crops (Sieling and Kage, 2010). The unfavorable preceding crop can decrease the oilseed rape seed yield (Sieling and Christen, 1997; Sieling and Christen, 2015). The information on the effect of different preceding crops on the development and yield of the oilseed rape is still limited.

In Northern Kazakhstan, Cherkasova and Rzaeva (2021) found that the best conditions for the oilseed rape seeding are after pure fallow. After legume crops, the highest oilseed rapeseed yields were obtained (Moller and Makowski, 1977; Christen and Sleling, 1995; Rathke and Diepenbrock, 2006; Fordoński et al., 2016).

Growing winter oilseed rape after winter wheat showed a higher plant population, a higher number of seeds per pod, and a higher number of seeds per square meter (Stobart and Bingham, 2013; Malik et al., 2015). A positive yield benefit for the oilseed rape following barley was also reported (Krupinsky et al., 2006; Jaskulska et al., 2014; Sieling and

Christen, 2015). In a study performed by Stobart (2012) the yield of the oilseed rape grown after wheat exceeded the yield of the oilseed rape grown as a monoculture by 12%. The oilseed rape is also a favorable predecessor for wheat (Kirkegaard et al., 2008). According to Sieling et al. (1997), the oilseed rape is not a self-compatible crop. The oilseed rapeseed yield grown after itself was reduced by 8-10% compared with the oilseed rape grown after a cereal crop (Christen and Sieling, 1995). Other authors reported up to 25% yield decrease after growing the oilseed rape as a monoculture (Hilton et al., 2013; Malik et al., 2015).

The aim of the current research is to evaluate the effect of the preceding crop on the oilseed rape development and seed yields.

MATERIALS AND METHODS

The trial was conducted in three consecutive vegetation seasons of the winter oilseed rape (2017/2018, 2018/2019, and 2019/2020). The research was performed on the experimental field of the department of "Agriculture and herbology" at the Agricultural University of Plovdiv, Bulgaria. The experiment was conducted by the long plots method with a total size of 100 m^2. For obtaining replications needed for statistical analyses, the long plots were divided into three separate smaller plots with a size of 33.33 m^2.

The soil on the experimental field is classified as Mollic Fluvisols, with an average sandy-clay mechanical composition, not high humus content, and a weak-alkaline reaction. The nitrogen content is low, the content of phosphorus varies from low to average and the potassium content is high (Popova et al., 2012).

The following crop rotations were under evaluation:

1. Winter wheat – winter oilseed rape;
2. Winter oilseed rape – winter oilseed rape;
3. Maize – winter oilseed rape.

The winter oilseed rape (*Brassica napus* L.) hybrid grown in the study was PT 228 CL (www.corteva.bg). The hybrid is bred to be grown by the Clearfield® technology. The sowing density was 330.000 plants ha^{-1}.

The winter wheat (*Triticum aestivum* L.) variety grown in the study was "Enola" (Kostov et al. 1999). The sowing density was 550.000 plants ha^{-1}.

The maize hybrid grown in the experiment was "Blason Duo", FAO Group 450, tolerant to the herbicide cycloxidim (https://euralis.bg//43-es-blason-duo/). The sowing density was 65.000 plants ha^{-1}.

The studied parameters of the winter oilseed rape were the following:

- Plant height at the end of vegetation (cm) (on 20 plants from each replication – 60 plants total);

- Number of primary brunches $plant^{-1}$ before harvest (on 20 plants from each replication – 60 plants total);

- Silique number $plant^{-1}$ before harvest (on 10 plants from each replication – 30 plants total);

- Oilseed rape seed yield (t ha^{-1}), by harvesting the whole there plots with a plot harvester of the Wintersteiger Company;

- Absolute mass of 1000 seeds (g) (in three replications) (Tonev et al., 2018);

- Hectoliter seed mass (kg) (in three replications) (Tonev et al., 2018);

- Seed oil content (%) was determined by the Soxhlet method as described by Ivanov and Popov (1994). The analyses were performed in three replications per rotation.

The performed growing technologies for the three rotations included combined fertilization with 250 kg ha^{-1} with N:P:K (15:15:15), followed by deep plowing. Before sowing the crops, disking on the depth of 15 cm and two harrowing operations on 8 cm of depth were done. Spring dressing with 250 kg ha^{-1} NH_4NO_3 was also performed.

During the three experimental seasons, the oilseed rape sowing after the preceding crop winter wheat or winter oilseed rape was done in the third decade of September. The sowing of the oilseed rape after predecessor maize was delayed to the second decade of November, because of the late harvesting of maize and the delayed soil tillage operations.

Statistical analysis of the collected data was accomplished by using Duncan's multiple range test of SPSS 19 program. Statistical differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSION

On the next three tables, the results concerning plant biometry, productivity, and seed quality are presented. Table 1 shows the results of the plant height as well as the number of primary branches and siliques plant^{-1}. According to many researchers, the plant growth and development are influenced by a preceding crop (Christen et al., 1992; Kalburtji and Gagianas, 1997; Arihara and Karasawa, 2000; Krupinsky et al., 2006; Haase et al., 2007; Rieger et al., 2008; Friberg et al., 2019). The findings correspond to the data obtained and related to the current study.

In rotation 1 (winter wheat- winter oilseed rape) the plat height at the end of vegetation was the highest in the three separate years of the experiment. Average for the period, the oilseed rape plants had a height of 139.50 cm. In the rotation where the oilseed rape was grown after itself the plants measures were shorter – 135.23 cm. The lowest results were found to be in rotation 3 where the winter oilseed rape was sown after maize – 134.40 cm average for the period.

Table 1. Growth parameters of oilseed rape

Plant height at the end of the vegetation (cm)				
Rotations	2018	2019	2020	Average
1. Winter wheat – winter oilseed rape	136.80 a	142.80 a	138.90 a	139.50 a
2. Winter oilseed rape – winter oilseed rape	136.00 a	135.20 b	134.50 b	135.23 b
3. Maize – winter oilseed rape	135.10 b	134.30 b	133.80 b	134.40 b
Number of primary brunches plant^{-1} before harvest				
Rotations	2018	2019	2020	Average
1. Winter wheat – winter oilseed rape	7.10 a	7.60 a	7.80 a	7.50 a
2. Winter oilseed rape – winter oilseed rape	7.20 a	6.80 b	6.10 b	6.70 b
3. Maize – winter oilseed rape	6.10 b	5.40 c	4.80 c	5.43 c
Silique number plant^{-1} before harvest				
Rotations	2018	2019	2020	Average
1. Winter wheat – winter oilseed rape	228.60 a	287.40 a	262.30 a	259.43 a
2. Winter oilseed rape – winter oilseed rape	220.10 a	187.30 b	138.00 b	181.80 b
3. Maize – winter oilseed rape	162.90 b	170.10 b	144.50 c	159.17 b

The number of primary branches before the harvest was also influenced by the preceding crops. In the first year of the study, the differences were not significant between the rotations of winter wheat – winter oilseed rape and winter oilseed rape – winter oilseed rape. After the continuous three years of winter oilseed rape mono-cropping (Rotation 2), the number of primary branches significantly decreased – 6.70 numbers plant^{-1}. The worst results for the indicator were found to be for rotation 3 (Maize – winter oilseed rape) – 5.43 numbers plant^{-1} average for the period.

The silique number plant^{-1} followed the tendency of the above-mentioned growth parameters. The highest silique number plant^{-1} for rotation 1 (winter wheat – winter oilseed rape) were recorded – 259.43 silique numbers average for the period. Medium average results were found for the mono-cropping of the winter oilseed rape (Rotation 2) – 181.80 silique numbers plant^{-1}. The lowest results for the studied parameter for rotation 3 were reported – 159.17 silique numbers plant^{-1}.

The winter oilseed rapeseed yield is presented in Table 2. Same as the growth parameters, the productivity of the plants was also influenced by the preceding crop. The highest seed yields were obtained for rotation 1 (Winter wheat – winter oilseed rape) – 3.43 t ha^{-1}. Lower yields were found for rotation 2 (Winter oilseed rape – winter oilseed rape). The obtained results correspond to the findings of Christen and Sieling, (1995) who reported lower oilseed rape seed yields after growing oilseed rape as a monoculture. The mono-cropping's negative influence was more pronounced in the second and in the third year of the experiment where the yields were 3.20 and 2.40 t ha^{-1} respectively. The productivity was the lowest for rotation 3 where the oilseed rape was sown after maize – 2.13 t ha^{-1} on average for the period. The obtained yields were with proved differences according to Duncan's Multiple Range test with the other two rotations.

Table 2. Oilseed rape seed yield (t ha^{-1})

Rotations	2018	2019	2020	Average
1. Winter wheat – winter oilseed rape	3.40 a	3.80 a	3.10 a	3.43 a
2. Winter oilseed rape – winter oilseed rape	3.60 a	3.20 b	2.40 b	3.07 a
3. Maize – winter oilseed rape	2.10 b	2.50 c	1.80 c	2.13 b

Table 3 shows the seed quality parameters as the oil content of the oilseed rape, the absolute mass of 1000 seeds, and the hectoliter seed mass. Similar to the above discussed and presented indicators, the analyzed quality parameters were influenced by the preceding crop. Rathke et al. (2005) reported high oil content for the oilseed rape grown after the winter barley. In the current study, the highest seed oil content was found for rotation 1 (winter wheat – winter oilseed rape) - 47.63 % average for the period. The lowest seed oil content was analyzed in the seeds of the plats from rotation 3 (maize – winter oilseed rape) – 46.17 %.

The absolute seed mass was the lowest for the plants grown after the maize predecessor (Rotation 3) – 3.67 g average for the period of the study. The highest results concerning this quality parameter for rotation 1 were recorded – 4.40 g. The obtained results are with proved differences with the other two rotations.

The hectoliter seed mass was also the lowest for rotation 3 – 64.47 kg average for the period of the study. The highest hectoliter seed mass for rotation 1 was recorded – 66.80 kg average for the experimental period, and the hectoliter seed mass of the oilseed rape plants grown as monoculture showed medium results – 65.47 kg.

Table 3. Oilseed rape seed quality parameters

Seed oil content (%)				
Rotations	2018	2019	2020	Average
1. Winter wheat – winter oilseed rape	48.00 a	47.40 a	47.50 a	47.63 a
2. Winter oilseed rape – winter oilseed rape	47.80 a	47.00 a	46.20 b	47.00 ab
3. Maize – winter oilseed rape	46.10 b	46.60 b	45.80 c	46.17 b
Absolute mass of 1000 seeds (g)				
Rotations	2018	2019	2020	Average
1. Winter wheat – winter oilseed rape	4.20 a	4.60 a	4.40 a	4.40 a
2. Winter oilseed rape – winter oilseed rape	4.10 a	3.90 b	3.60 b	3.87 b
3. Maize – winter oilseed rape	3.80 b	3.50 c	3.70 b	3.67 b
Hectoliter seed mass (kg)				
Rotations	2018	2019	2020	Average
1. Winter wheat – winter oilseed rape	66.20 a	67.40 a	66.80 a	66.80 a
2. Winter oilseed rape – winter oilseed rape	66.50 a	65.20 b	64.70 b	65.47 ab
3. Maize – winter oilseed rape	65.00 b	64.20 c	64.80 b	64.47 b

CONCLUSION

The obtained results confirmed that the preceding crop influences the growth and development of the winter oilseed rape. If sown after the winter wheat the highest results for all studied parameters were obtained.

It was confirmed that growing the winter oilseed rape as a monoculture is not a good agronomical practice. In the second year of the study, the results of the studied indicators (vegetative, productive, and qualitative) in the mono-cropping system of the winter oilseed rape were diminished. In the third experimental year, the result's decrease was even more pronounced.

It was found that maize is an inappropriate preceding crop for the winter oilseed rape. When the oilseed rape was grown after maize the lowest results for all parameters evaluated were obtained.

REFERENCES

Abbadi, A., & Leckband, G. (2011). Rapeseed breeding for oil content, quality, and sustainability. Eur. J. Lipid Sci. Technol., 113, 1198–1206.

Arihara, J., & Karasawa, T. (2000). Effect of previous crops on arbuscular mycorrhizal formation and growth of succeeding maize. *Soil Science and Plant Nutrition*, *46*(1), 43-51. https://doi.org/10.1080/00380768.2000.10408760

Brennan, R., & Bolland. D. (2007). Effect of fertilizer phosphorus and nitrogen on the concentrations of oil and protein in grain and the grain yield of canola (*Brassica napus* L.) grown in south-western Australia. *Aust. J. Exp. Agri*., 47, 984–991.

Cherkasova, E., & Rzaeva, V. (2021). Influence of the predecessor and the seeding rates on the rape productivity. IOP Conf. Series: *Earth and Environmental Science*, 839, 1-6. doi:10.1088/1755-1315/839/2/022037

Christen, O., & Sleling, K. (1995). Effect of Different Preceding Crops and Crop Rotations on Yield of Winter Oil-seed Rape (*Brassica napus* L.). *Journal of Agronomy & Crop Science*, 174, 265-271.

Christen, O., Sieling, K., & Hanus, H. (1992). The effect of different preceding crops on the development, growth and yield of winter wheat. *European Journal of Agronomy*, *1*(1), 21-28.

Fordoński, G., Pszczółkowska, A., Okorski, A., Olszewski, J., Załuski, D., Gorzkowska, & A. (2016). The yield and chemical composition of winter oilseed rape seeds depending on different nitrogen fertilization rates and preceding crop. J. Elem., *21*(4), 1225-1234. DOI: 10.5601/jelem.2016.21.2.1122

Friberg, H., Persson, P., Jensen, D., & Bergkvist, G. (2019). Preceding crop and tillage system affect winter survival of wheat and the fungal communities on young wheat roots and in soil. FEMS Microbiology Letters, 366 (15), 1-7. https://doi.org/10.1093/femsle/fnz189

Haase, T., Schüler, C., Piepho, H., Thöni, H., & Hes, J. (2007). The Effect of Preceding Crop and Pre-Sprouting on Crop Growth, N Use and Tuber Yield of Main crop Potatoes for Processing Under Conditions of N Stress. *Journal of Agronomy and Crop Science*, 193, 270-291. https://doi.org/10.1111/j.1439-037X.2007.00264.x

Hilton, S., Bennett, A., Chandler, D., Mills, P., & Bending, G. (2018). Preceding crop and seasonal effects influence fungal, bacterial and nematode diversity in wheat and oilseed rape rhizosphere and soil. *Applied Soil Ecology*, 1-13.

Hilton, S., Bennett, A., Keane, G., Bending, G., Chandler, D., Stobart, R., & Mills, P. (2013). Impact of Shortened Crop Rotation of Oilseed Rape on Soil and Rhizosphere Microbial Diversity in Relation to Yield Decline. *PLOS ONE*, 8 (4). e59859. https://doi.org/10.1371/journal.pone.0059859

https://euralis.bg//43-es-blason-duo/

https://www.corteva.bg/content/dam/dpagco/corteva/eu/bg/bg/products/files/Catalogue_OSR_2020_Bulgaria.pdf

Ivanov, K., & Popov, N. (1994). Rakovodstvo za uprazhneniya po biohimiya na rasteniyata. Zemizdat, Sofiya. [A Guidebook for Exercises on Biochemistry of the Plants. Zemizdat, Sofia].

Jaskulska, I., Jaskulski, D., Kotwica, K., Piekarczyk, M., & Wasilewski, P. (2014). Yielding of winter rapeseed depending on the forecrops and soil tillage methods. *Annales Unversitatis Mariae Curie-Sklodowska*, 69, 30–38.

Kalburtji, K., & Gagianas, A. (1997). Effects of Sugar Beet as a Preceding Crop on Cotton. *Journal Agronomy & Crop Science*, 178, 59-63. https://doi.org/10.1111/j.1439-037X.1997.tb00351.x

Kirkegaard, J., Christen, O., Krupinsky, J., & Layzell, D. (2008). Break crop benefits in temperate wheat production. Field. *Crop. Res*., 107, 185–195.

Kostov, K., Tsenov, N., Stoeva, I., Iliev, I., & Petrova, T. (1999). Enola – new variety of winter common wheat. *Plant Science*, 35, 347 – 350.

Krupinsky J., Tanaka, D., Merrill, S., Liebig, M., & Hanson, J. (2006). Crop sequence effects of 10 crops in the northern Great Plains. *Agricultural Systems*, 88, 227–254. https://doi.org/10.1016/j.agsy.2005.03.011

Malik, R., Seymour, M., French, R., Kirkegaard, J., Lawes, R., & Liebig, M., (2015). Dynamic crop sequencing in Western Australian cropping systems. *Crop Pasture Science*, 66(6), 594–609. https://doi.org/10.1071/CP14097

Moller, W., & Makowski, N. (1977). Ergebnisse beim Anbau von Winterraps nach Getreidevorfriichten. Tag. Ber. Akad. Landwirtsch. Wiss, DDR, Berlin 149, 69-76.

MZH (2020). Agrostatistics, yields from field crops - harvest 2020. Ministry of

Agriculture, Food and Forestry. Retrieved from: https://www.mzh.government.bg/media/filer_public/2021/04/13/ra384_publicationcrops2020_preliminarydata_site.pdf

Popova, R., Zhalnov, I., Valcheva, E., Zorovski, P., Dimitrova, M. (2012). Estimates of environmental conditions of soils in Plovdiv region in applying the new herbicides for weed control in major field crops. *Journal of Central European Agriculture*, 12(3), 595-600.

Rathke, G., & Diepenbrock, W. (2006). Energy balance of winter oilseed rape (*Brassica napus* L.) cropping as related to nitrogen supply and preceding crop. *European Journal of Agronomy*, 24, 35–44. https://doi.org/10.1016/j.eja.2005.04.003

Rathke, G., Christen, O., & Diepenbrock, W. (2005). Effects of nitrogen source and rate on productivity and quality of winter oilseed rape (*Brassica napus* L.) grown in different crop rotations. *Field Crops Research*, 94, 103–113.

Rieger, S., Richner, W., Streit, B., Frossard, E., & Liedgens, M. (2008). Growth, yield, and yield components of winter wheat and the effects of tillage intensity, preceding crops, and N fertilization. *European Journal of Agronomy*, 28, 405-411. https://doi.org/10.1016/j.eja.2007.11.006

Sieling, K. & Christen, O. (2015). Crop rotation effects on yield of oilseed rape, wheat and barley and residual effects on the subsequent wheat. *Archives of Agronomy and Soil Science, 61*(11), 1531-1549. DOI: 10.1080/03650340.2015.1017569

Sieling, K., & Christen, O. (1997). Effect of preceding crop combination and N fertilization on yield of six oil-seed rape cultivars (*Brassica napus* L.). *European Journal of Agronomy*, 7, 301-306.

Sieling, K., & Kage, H. (2010). Efficient N management using winter oilseed rape. A review. *Agronomy for Sustainable Development*, 30, 271–279. https://doi.org/10.1051/agro/2009036

Sieling, L., Christen, O., Nemati, B., & Hanus, H. (1997): Effect of previous cropping on seed yield and yield components of oil-seed rape (*Brassica napus*). *European J. Agron*., 6, 215-223.

Stobart, R. (2012). Oilseed rape: the impact of rotational intensity on crop performance. Asp. *Appl. Biol*., 117, 145–150.

Stobart, R., & Bingham, I. (2013). Impact of previous cropping on winter oilseed rape (including related studies addressing the impact of oilseed rape cropping components of yield and rooting). *Report for HGCA Projects* RD-2003–2922, RD-2009–3648 and RD-2009–3649.

Tonev, T., Tityanov, M., Mitkov, A., Yanev, M., & Neshev, N. (2018). A Guidebook for Exercises on General Agriculture and Herbology. Publisher: “Biblioteka Zemedelsko Obrazovanie”, 71-72. (A guidebook in English)

Vinnichek, L., Pogorelova, E., & Dergunov, A. (2019). Oilseed market: Global trends. IOP Conf. *Ser. Earth Environ. Sci*., 274, 0112030.

Wu, J., & Muir, A. (2008). Comparative structural, emulsifying, and biological properties of 2 major canola proteins, cruciferin and napin. *Journal of Food Science*, 73. 210–216. doi:10.1111/j.1750-3841.2008.00675.x