The influence of tillage methods on the yield of oilseeds of the Brassicaceae family

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Abstract. The analysis of productivity studies of spring oilseeds of the Brassicaceae family during their cultivation on gray forest soil in the crop rotation link in Ryazan region, Russia is proposed. The influence of variants of the main tillage on the yield of spring rape variety Ratnik and spring rape variety Lipchanka has been studied. The experiments were carried out in 2015-2020 on dark gray forest soils. Agrotechnical measures for the cultivation of spring oilseeds are typical for the Non-Black Earth Zone of Russia, which includes Ryazan region. On average, according to the research results, the highest yield in spring rape was recorded on the variant of the fallow link of the crop rotation + moldboard processing (3.13 t/ha), in the spring rape (2.56 t/ha). When determining the biological activity of the soil, the method of linen with a density of 150 g/m² was used. In the experiment, on the variant with the moldboard method, when using a reversible plow, the degree of decomposition of the linen was the greatest in the experiment. In agrocenoses of agricultural crops, a pattern was noted for an increase in biological soil activity, in rape the degree of decomposition was recorded in 45.3 % and in spring coleseed it was 41.9 %.

1. Introduction

When planning high yield of agricultural crops for the next year and greater profits from spring oilseeds, including spring rape and summer rape, it is very important to strictly observe the cultivation technology at all stages of its implementation [1-5]. It is necessary to determine and carry out high-quality tillage since autumn, and thoroughly prepare for winter sowing [6, 7]. Soil cultivation is an essential factor in agricultural technology when obtaining high yields of seeds.

At different stages of the formation of agriculture as a science, the requirements for tillage changed, they were formed with the development of science and technology [8-13]. At the early stages, the main thing was to prepare the soil for planting seeds. With the development of technology, there was an increase in the power supply, the cultivation tools were improved, the depth of cultivation increased, being an important factor in the intensification of soil cultivation [14].

Currently, there are tendencies in soil cultivation with mid-depth, shallow cultivation, which underlie soil conservation cultivation [15-18].

The effectiveness of the main tillage largely depends on its scientifically substantiated implementation according to a certain system, considering the agrophysical state of the arable layer,
climatic and weather conditions, the characteristics of the forecrop, the species composition of weeds, the degree of weeds of the field, and more [19, 20, 21].

When cultivating rape and summer rape, particular importance should be given to leveling the surface of the field. This is one of the unsolved problems of agriculture [22]. According to the calculations of specialists, only as a result of insufficient leveling of the surface layer of the soil, the yield decreases by 20 % or more [23].

The purpose of the research was to determine the most effective method of soil cultivation in the link of crop rotation in crops of spring oilseed cabbage crops in the conditions of Ryazan region.

2. Materials and methods
The experiments were carried out in the conditions of Mikhailovsky district of Ryazan region on dark gray heavy loamy soils in 2015-2020 [24].

Agrochemical characteristics of the experimental soil were as follows: humus 4.7-5.6 %, mobile phosphorus 148.0-170.4 m/kg of soil, mobile potassium 164.1-167.2 mg/kg of soil, nitrate nitrogen 15.6-18.9 mg/kg of soil, ammonium nitrogen 0.70-1.07 mg/kg of soil, saline pH 5.53-5.55.

The studies used the following variants of the crop rotation link - fallow: cropped fallow (annual grasses for green fodder) - winter wheat - spring oilseeds; and row crops: potatoes - spring wheat - spring oilseeds.

Spring rape Brassica napus oleifera Metzger of variety Ratnik and spring coleseed Brassica campestris L. of variety Lipchanka were studied as spring oilseeds

The method of the main processing (factor C) included the minimum one with disc harrow BDM-Agro 4x4 to a depth of 8-10 cm, the milling one with vertical milling cutter Lemken Zirkon 7/400 to a depth of 12-14 cm and mouldboard plowing with Kuhn Multi-Master 123/5-40 reversible plow to a depth of 18-20 cm. The experiment repeated four times annually.

Agrotechnical measures for the cultivation of spring rape and coleseed were generally accepted for the Non-Black Earth Zone of Russia. The crop sowing period was the third decade of April.

When detecting the biological activity of dark gray forest soil, the method of linen with a density of 150 g/m² was used. The studies were carried out using generally accepted methods. Experimental data were statistically processed using the analysis of variance.

3. Results
The high level of agriculture and the wider use of effective means of protecting cabbage oilseeds create the possibility of expanding the crops of spring rape and coleseed by non-fallow and fallow forecrops. In this connection, the issues of fertility and microbiological processes in the soil are an important area of research.

One of the significant characteristics of soil fertility is the functioning of microbiological processes. Therefore, the most important indicator of the "biological activity of the soil" is a complex of agrobiological reactions, processes and transformations that occur in the soil layer.

The average degree of decomposition of linen according to the variants was 40.9 %. In dry 2018 and 2019, the decomposition rate of linen turned out to be 33.8 % and 29.3 %, respectively. In 2015 and 2020, being optimal for spring rape and coleseed, it amounted to 56.3 % and 58.6 %, respectively.

On average, over the years of research, it was revealed that there was no significant difference in the biological activity of the soil along the crop rotation link: in the fallow link, the degree of decomposition of linen was 44.7 % that of the row crop was 42.5 %. For cabbage crops, a pattern was found to increase the biological soil activity, in rape the degree of decomposition was 45.3 % and in coleseed it was 41.9 %.

On average, the minimum disc processing with disc harrow BDM-Agro gave 32.4 % decomposition of linen, where a high degree of decomposition was observed in the upper layer of 0-10 cm.

The increase in biological activity when milling with a Lemken Zirkon cutter led to an increase of 44.6 %. The decomposition of the linen was already recorded in the 0-15 cm layer. At the same time,
the mouldboard method carried out by a Kuhn Multi-Master reversible plow contributed to the achievement of the biological activity of the soil, on average over the years of experiments, up to 53.8%. And in the years optimal for the growth and development of oilseed cabbage crops (2015, 2020), the biological activity of the soil reached 66.4% and 70.4%, respectively. With the mouldboard method with a reversible plow, the degree of decomposition of linen was noted to a depth of 20 cm and was the maximum in the experiment.

Analyzing the placement of the studied crops in the fallow and row crop links of the crop rotation in the years of experiments, the maximum efficiency of the fallow link on the seed yield was confirmed (Table 1).

| Crop rotation link (A) | Crop (B) | Basic processing method (C) | Average yield, t/ha | Average by factor A | Average by factor B | Average by factor C |
|------------------------|---------|----------------------------|---------------------|---------------------|---------------------|---------------------|
| Fallow (A₁)            | Rape (B₁) | Minimum C₁                 | 2.71                | 2.64                | 2.80                | 2.35                |
|                        |         | Milling C₂                 | 2.92                |                     |                     | 2.53                |
|                        |         | Mouldboard C₃              | 3.13                |                     |                     | 2.74                |
|                        | Spring coleseed (B₂) | Minimum C₁                 | 2.16                | 2.28                |                     | –                   |
|                        |         | Milling C₂                 | 2.34                | –0.52               | 0.18                | (7.7 %)             |
|                        |         | Mouldboard C₃              | 2.56                |                     | (–18.6 %)           | 0.39 (16.6 %)       |
| Row crop (A₂)          | Rape (B₁) | Minimum C₁                 | 2.51                | 2.44                |                     |                     |
|                        |         | Milling C₂                 | 2.65                | –0.20               |                     |                     |
|                        |         | Mouldboard C₃              | 2.88                | (7.6 %)             |                     |                     |
|                        | Spring coleseed (B₂) | Minimum C₁                 | 2.01                |                     |                     |                     |
|                        |         | Milling C₂                 | 2.21                |                     |                     |                     |
|                        |         | Mouldboard C₃              | 2.37                |                     |                     |                     |
| Average over the years, t/ha |         |                            | 2.54                |                     |                     |                     |

The seed yield increased with an increase in the depth of soil cultivation, as well as the intensity of the processing variant, which was traced both in spring rape and coleseed. On average, the maximum yield of rape was observed in the variant of the fallow link of the crop rotation + mouldboard cultivation (3.13 t/ha) and in the coleseed (2.56 t/ha). Milling in all the years of experiments gave average indicators of the yield of spring oilseeds by factor C from 2.05 t/ha in 2019 to 2.90 t/ha in 2020.

Oil content of spring rape variety Ratnik varied, on average, in the range of 43.4-47.6% and that of spring coleseed variety Lipchanka it was 42.0-45.1%. No significant dependences on the variants of the crop rotation link and the intensity of processing were found.

4. Conclusion
In summary, the dependence of the biological activity of the soil was noted on weather factors and the degree and depth of soil cultivation. The maximum intensity of the decomposition of linen was in the fallow link of the crop rotation with the use of the mouldboard method of the main soil cultivation for oilseed cabbage crops. The maximum yield of rape was observed in the variant of the fallow link of the crop rotation + mouldboard cultivation (3.13 t/ha) and that of colesseed it was (2.56 t/ha).

A high increase in oilseeds on this variant was 0.47 t/ha, where the LSD05 by factor C equal to 0.097 t/ha relative to the minimum main tillage was recorded in 2015. The study revealed a tendency to increase the yield of seeds of spring oilseeds in the fallow link of the crop rotation relative to the row crop.
References

[1] Rezvani M, Kluth H, Bulang M, Rodehutscord M 2012 Variation in amino acid digestibility of rapeseed meal studied in caecotomised laying hens and relationship with chemical constituents. Br. Poult. Sci. 53 665–647
[2] Nakayeva A A and Okazova Z P 2017 On the competitiveness of field crops. Successes of modern science 2(12) 191-195
[3] Byshov N V, Uspenskiy I A, Yukhin I A and Limarenko N V 2020 Ecological and technological criteria for the efficient utilization of liquid manure IOP Conf. Series: Earth and Envir. Sc. 422 012069
[4] Vinogradov D V, Stenchkina M Y, Vasileva V M 2020 Increasing the oats (Avena sativa) productivity when co-use of fertilizers and growth regulator in conditions of the nonchernozem zone of Russia. Intern. Transact. J. of Engin., Managem. & Appl. Sc. & Techn. 11 10
[5] Vinogradov D V, Fedotova M Yu, Kryuchkov M M, Byshov N V, Kostin Ya V, Ushakov R N 2019 Influence of Co-Use of Mineral, Organo-Mineral Microbiological Fertilizers and Growth Regulator on Oats Yield. Biosc. Biotech. Res. Comm. Special Issue 12 (5) 299-307
[6] Pityurina I S, Vinogradov D V 2021 Potato yield on dark gray soils when using microbiological preparation. E3S Web Conf., 285 02008 International Conference on Advances in Agrobusiness and Biotechnology Research (ABR 2021) https://doi.org/10.1051/e3sconf/202128502008
[7] Zakharova O A, Vinogradov D V, Byshov N V, Musaev F A, Kostin Ya V 2019 Results of Monitoring Studies of Dried Peat Soils. Intern. J. of Adv. Biotech. and Res. (IUBR) 10 2 474-489
[8] Shchur A V, Valchko V P, Vinogradov D V 2016 Effect of different levels agroecological loads on biochemical characteristics of soil. South of Russia: ecology, development. 11(4) 139-148
[9] Shchur A, Valchko V, Vinogradov D, Valkho O 2016 Influence of biologically active preparations on Cs-137 transition to plants from soil in the territories contaminated as the result of Chernobyl accident. Impact of Cesium on Plants and the Environment. Springer International Publishing Switzerland 51-70.
[10] Vinogradov D V, Terekhina O N, Byshov N V, Kryuchkov M M, Morozova N I, Zakharova O A 2018 Features of applying biological preparations in the technology of potato growing on gray forest soils. Intern. J. of Engin. and Techn. 7 4 36 242-246
[11] Mustafayev M G, Mazhaysky Yu A, Vinogradov D V 2018 Diagnostic Parameters of Irrigated Meadow-Serozem and Alluvial-Meadow Soils of the Mungan-Sal’yany Massif of Azerbaijan. Rus. Agr. Sc. 44(6) 551–558
[12] Vasileva V 2015 Aboveground to root biomass ratios in pea and vetch after treatment with organic fertilizer. Glob. J. of Env. Sc. and Manag. (2) 71-74
[13] Vinogradov D V, Evsenina M V, Novikova A V 2021 Improving the conditioning of wheat grain when preparing it for grinding into graded flour. IOP Conf. Series: Earth and Envir. Sc. 723 022081 doi:10.1088/1755-1315/723/2/022081
[14] Vinogradov D V, Makarova M P, Kryuchkov M M 2021 The use of mineral fertilizers in sunflower crops in the conditions of Ryazan region. IOP Conf. Series: Earth and Envir. Sc. 624 012077 doi:10.1088/1755-1315/624/1/012077
[15] Ciurescu G 2009 Efficiency of soybean meal replacement by rapeseed meal and/or canola seeds in commercial layer diets, Arch. Zootecnh., 12 27–33
[16] Vasileva V, Kertikov T, Ilieva A 2017 Dry mass yield and amount of fixed nitrogen in some forage legume crops after treatment with organic fertilizer Humustim. Bulg. J. of Agr. Sc. 23 (5) 816-819
[17] Lupova E I, Sazonkin K D, Vinogradov D V 2021 Yield of winter rape in Ryazan region. IOP Conf. Series: Earth and Envir. Sc. 723 022031 doi:10.1088/1755-1315/723/2/022031
[18] Toghyani M, Mohamadalehi A, Gheisari A, Tabeidian S 2009 The effect of low-glucosinolate rapeseed meal in diets with multi-enzyme supplement on performance and protein digestibility in broiler chicks, J. Anim. Feed Sci., 18, 313–321
[19] Vinogradov D V, Konkina V S, Kostin Y V, Kruchkov M M, Zakharova O A, Ushakov R N
2018 Developing the regional system of oil crops production management. Res. J. of Pharmac., Biol. and Chem. Sc. (RJPBCS) India 9 (5) 1276-1284

[20] Gulidova V A, Zubkova T V, Kravchenko V A, Dubrovina O A 2017 The dependence of photosynthetic indices and the yield of spring rape on foliar fertilization with microfertilizers. OnLine J. of Biol. Sc. 17 (4) 404-407

[21] Zubkova T, Motyleva S, Dubrovina O, Brindza J 2021 The study of rapeseeds ash composition in the conditions of the agroecological experiment. Potravinarstvo Slovak J. of Food Sc. 15 156–161. https://doi.org/10.5219/1356

[22] Roth-Maier D A, Kirchgessner M 1995 Feeding of 00-rapeseed seed to fattening chickens and laying hens, Archiv für GeHiigelkunde, 59 241–246

[23] Teterin V, Terentyev V, Andreev K, Shemyakin A and Teterina O 2020 Study of the parameters and operating modes of the installation for aerosol treatment of seed grain. E3S Web of Conferences: Ecological and Biological Well-Being of Flora and Fauna 203 02011

[24] Vinogradov D V, Naumtseva K V, Lupova E I 2019 Use of biological fertilizers in white mustard crops in the non-Chernozem zone of Russia. IOP Conf. Series: Earth and Envir. Sc. 341(1) 012204