

Methods to Increase Spring Rape Yield and Rape Product Quality in the Conditions of Central Black Earth Region Woodland Grass

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Abstract

The aim of research is the development of elements of spring rape cultivation technology based on complex micro fertilizers, herbicides, and more adaptive varieties and hybrids that can maximize the potential productivity of forest conditions in the Central Black Earth region. The article presents the results of research on biometrics and generally shows the productivity of spring rape foreign varieties and hybrids. It shows the results of studying the herbicide impact on weediness and productivity of spring rape. It was found that the use of tank-mix herbicide of water and glycol solution (0.3 l/ha) + Beryl, emulsion concentrate (0.7 l/ha) provided receiving clean harvests from weeds and high yield, and hybrids of foreign selection Siesta and Hidalgo ensure high yields and the largest oil gathering per 1 hectare. It was also found that one year after applying the herbicide Lear and Beryl in pure form and in a tank mixture there was no adverse effect on the subsequent sensitive harvests – fodder beet and soybean. The paper provides the results of studies on the effect of micronutrients on the elements of yield structure of spring rape and productivity in general. It was found that the use of micronutrients provided obtaining high yields.

Keywords: Biological Efficiency, Herbicides, Micro Fertilizers, Productivity, Rape, Yield Structure Elements

1. Introduction

Rape is a strategic culture that allows you to receive not only food, animal feed, and renewable industrial raw materials, which is widely used in transportation and industry. In the long-term forecasts of experts, the demand for oilseed rape for these purposes will increase.

In this context, it becomes urgent to develop the elements of rape zonal technology, allowing increasing its productivity, oil, and generally providing a higher gross output of vegetable oil from 1 hectare. It is therefore necessary further to improve chemical method of weed control, introduction of high-yielding varieties and hybrids.

Research tasks:

- Examine the varieties and hybrids of spring rape Western European breeding, most suitable for cultivation in soil and climatic conditions, forest-steppe of CPR and give a comparative assessment of their productivity.
- Examine the selective effect of herbicides Lear and

Beryl on population dynamics, species composition and mass of weeds in spring rape harvests and their effects in the sensitive harvests (fodder beet and soybean).

- Evaluate the biological and economic efficiency of herbicides Lear and Beryl, and their tank mix on the development of plants, the formation of yield and production quality of spring rape.
- Set the characteristics of yield formation and quality of spring rape seeds using different complex micronutrients.
- Identify the most effective processing time micro fertilizers plants.

2. Literature Review

Rape is a valuable oilseed high-protein harvests that feed on the advantages than many other agricultural plants^{1,2}.

The main oilseeds in Russia is a sunflower, its share in the production of oilseeds was 87.5%³. Oilseed agriculture owes an important part of agricultural production of

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many countries. Derived from vegetable oils make them, on the one hand, the basis of human nutrition, on the other hand- it is a necessary raw material for various industries⁴.

Rapid interest in rape due to the development of bioenergy in the world market, and the demand for oil-bearing raw materials increases its production in the Russian Federation. It is the use of biofuels can partially reduce the consumption of limited reserves of natural oil^{5,6}.

The range is quite wide use of rape. Above all, it is cultivated as oilseeds. Today, 80% of the gross harvest of rapeseed is used to produce oil, which satisfies all the requirements for the quality of the food⁷. Value rapeseed oil is that it contains the unsaturated fatty acids are essential to man, but it is not formed in the body⁸. Even in rapeseeds contained up to 0.12% of essential oils⁹.

One of the most important factors in the development of agriculture and the harvest is graded potential harvests¹⁰. A new direction in the selection of a summer rape is the creation of promising early-maturing two or three zero varieties and hybrids, which are characterized by low acid oil glucosinolates and fibre in the seeds. The creation of new varieties of rape, will allow in the near future expanding the market for its seeds¹¹.

In the scientific literature are ambiguous and sometimes conflicting data on the effect of environmental conditions on the quality characteristics of rape. However, most researchers point out that weather conditions have a definite impact on the biochemical composition of the seed.

World experience of recent years shows that the cultivation of spring rape advantage should be given to heterosis of hybrids. The reason is that for oilseeds and seed husk content among varieties of oilseed rape is now at its biological limits.

Compared with traditional varieties, hybrids have the following advantages:

- Increase in the harvest yield up to 20%.
- Great stability in terms of productivity, uniformity, and tolerance to stress factors.
- Choice of a free term for planting.

The rapid growth of hybrids (compared with grades) allows finishing the harvest, without disturbing the optimal planting dates later in the harvest rotation of winter harvest.

Successful cultivation of this harvest is also impossible without the use of chemical methods of weed control, which now occupy a dominant position in the system of protective measures in the cultivation of rape, because of

its ease of use, fast action, and high efficiency. Biological features of rape are its low competitiveness of weeds in the early phases of development. Weeds not only inhibit the growth and development of plants rape consuming soil nutrients and moisture as well as contribute to the spread of pests and plant diseases difficult to care for harvests complicate harvest, making it difficult to clean the seeds. Therefore, the study and application of cenosis weed herbicides in the fight with him in the spring rape harvests is an important link in the system of phytosanitary practices contributing to the overall increase in the production of this harvest. Net harvests from weeds are one of the important prerequisites for a high yield of rapeseed. The average yield loss caused by clogging, especially in sparse harvests, reaches 15 percent or more. Losses can be higher if sparse harvests, with bad soil conditions x or by dry weather immediately after planting^{12,13}. The method of controlling weeds in harvests concerning the integrated use of all the measures in the rotation suggested by German scientists^{14,15} is considered the most effective method. The most harmful weeds include: juvenile spring cereals (wild mustard, pigweed white, wild radish, wild oats vulgare), juvenile late spring (barnyardgrass, foxtail species, amaranth thrown back), juvenile wintering (shepherd's purse, *Thlaspi arvense*, types of chamomile), perennial weed forming (creeping thistle, sow thistle field, *Barbarea vulgaris*, field bindweed), perennial rhizomatous (couch grass, horsetail)¹².

The widespread use of herbicides creates the danger of pollution of the soil, plants, and food harvests residues of drugs, as well as the products of their transformation. That is why the use of technology, transportation, transformation, and inactivation of herbicides in soil and harvests must be kept under constant review.

Evaluation of environmental hazards of pesticides is a problem which solution is necessary to standardize procedures, reflecting a number of aspects of the negative effects of pesticides on the environment. Such procedures include an assessment of the side effects of pesticides on group of organisms in agrocoenosis, which regulate the dynamics of pests and harvests rotation, and on this basis - the development of criteria of danger¹⁶.

The absence of negative consequences has always been considered one of the most important positive characteristics of herbicides. Most of the currently used substances have such a property at following regulations

for its applications¹⁷.

Currently herbicide approved for use in Russia, face with high requirements. These requirements include high biological (herbicidal) activity against weeds and selectivity to the cultural; cost-effectiveness; minimal risk of negative impacts on the environment, human useful fauna and flora.

Public service monitoring and quality control of soil for the assessment of soil environment use a variety of methods that can be divided into chemical and biological. The most promising research of soil phytotoxicity is bioassay. The bioassay is the procedure to establish toxicity of the medium with the test objects, which in turn signal the danger irrespective of any substance in any combination and cause changes in vital signs in them.

In Europe and in the US, assessment if the toxicity of herbicides is made using *Lemnaceae* test as the test object are the aquatic higher plants of the family *Lemnaceae* which are characterized by the simplicity of the structure, the rapid rate of reproduction and high sensitivity¹⁸.

In terms of ED50, highly sensitive are beet and mustard, medium sensitive are corn, rice, and soybeans and relatively resistant are wheat and barley¹⁹.

Another important factor in harvest production, especially technical, is the use of micro fertilizers containing boron, molybdenum, copper, manganese and other elements²⁰⁻²³. Currently, more attention is paid to finding ways of applying fertilizers, which could ensure the maximum utilization of nutrients by plants. By adjusting the conditions of the power plant, it is possible to enhance the growth of plants, accelerate, or delay their development and to increase the yield and quality of harvests, to realize fully the genetically inherent in the plants are able to generate high productivity.

3. Methodology

The experiments were conducted based on Bunin Yelets State University in 2009-2011. There has been environmental strain testing foreign varieties and hybrids of rape: *Sfinto Griffin* variety, *Siesta* and *Hidalgo* hybrids. The standard has been taken one of high-yielding varieties of Russian breeding – *Ratnik*. Research herbicides and micronutrients conducted on harvests of spring rape of *Ratnik*. The scheme for experiences with herbicides included the following options: K without herbicides, I-Lir, WGS (0.3 l/ha), II-Beryl, CE (0.7 l/ha), III-Lir, WGS

(0.3l/ha) + Beryl CE (0.7l/ha), IV (standard) – Lontrel 300, WS (0.4 l/ha). These herbicides are designed by Kirovo-Chepetskaya chemical company and in its composition includes different active ingredient. Lir contains 351 g/l of clopyralid, and Beryl-120 g/l of clethodim. Driving experience with the study of micronutrients included three-term treatment of vegetative plants rape: 1- single treatment phase outlet; 2- single treatment in the budding phase; 3- double treatment in the phase of budding and sockets, following microfertilizers: Boroplyus (0.75 L/ha); Microelectr (0.2 l/ha); Plantafol 20:20:20 (1.0 kg/ha); Plantafol 5:15:45 (1.0 kg/g; The Power of Life (0.4 l/ha) and Lignohumate mark BM potash (0.15 l/ha).

On experimental plots, there was applied agricultural technology, common in the Lipetsk region. Preceded of spring rape was winter wheat. Fertilizers were added to the main autumn tillage as NPK (N_{16} ; P_{16} ; K_{16}) and spring ammonium nitrate (N_{20}) in a row.

4. Results

4.1 Assessment of Varieties and Hybrids of Spring Rape in Biological and Economic Characteristics and Agronomic Efficacy of Lir and Beryl Herbicides

Our research showed that agro-climatic conditions of CPR allow for successfully cultivates new varieties (*Sfinto* and *Griffin*) and hybrids (*Siesta* and *Hidalgo*) spring rape. They are provided with living and biotic factors in a given region matured in the first (extreme weather conditions, 2010) and the second half of August (2009 and 2011). The most precocious hybrid *Hidalgo* turned to the duration of the growing season 80-94 days and later – *Sfinto* 86-99 days.]

The highest yield showed hybrids (Figure 1). In comparison with the varieties of oilseeds amounted to an additional fee of 0.3 t/ha. The most fruitful was a hybrid *Siesta* – 1.81 t/ha.

Sfinto and *Griffin* showed almost the same yield 1.64-1.61 t/ha, the variety of the Russian breeding *Ratnik* was inferior to yield hybrid by 0.67-0.58 t/ha, and the varieties of the Western ecotype totaled to 0.5-0.47 t/ha.

The content of crude fat was greater in the seeds of spring rape varieties *Ratnik*, averaging 43.73% (Figure 2). The hybrid seeds *Siesta* and *Hidalgo* contained slightly less fat at 1.22% and 1.39% respectively. Most minimum

fat content was observed in varieties *Sfinto* (41.01%) and *Griffin* (40.0%).

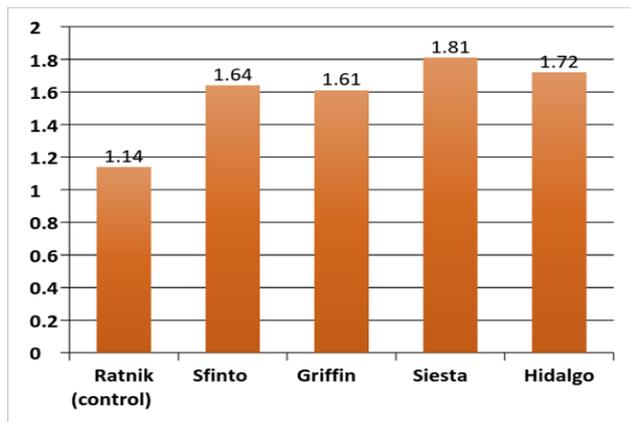


Figure 1. The yield varieties and hybrids of spring rape, t/ha (2009-2011).

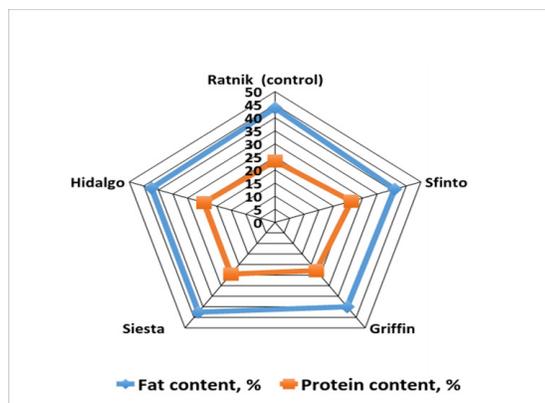


Figure 2. The content of crude fat and protein in the seeds of different varieties and hybrids of spring rape, % (2009-2011).

The maximum content of crude protein in the average for the year was noted in the seed varieties *Sfinto* – 26.17%, which exceeded the standard variety *Ratnik* 2.72%. The lowest crude protein content in the seed varieties was *Griffin* – 22.86%. Of the two investigated hybrids had the highest protein content hybrid *Siesta* – 24.50%. *Ratnik* content of crude protein occupied an intermediate position between the studied varieties and hybrids.

For spring rape, important indicator is the gross yield of oil and protein per unit area. Collection of fat and protein is determined by not only the percentage of the seeds, but the quantity of food harvests.

Thus, the maximum gross yield of fat was observed in hybrids *Siesta* and *Hidalgo*, where, on average over

three years of research, he has made 782 and 741 kg/ha, exceeding the collection of fat standard variety, *Ratnik* 283 and 242 kg/ha, or 56.7%, and 48.5%, respectively (Figure 3). The increase of gross yield of fat compared to standard cultivars *Sfinto* and *Griffin* was 174 and 145 kg/ha, respectively.

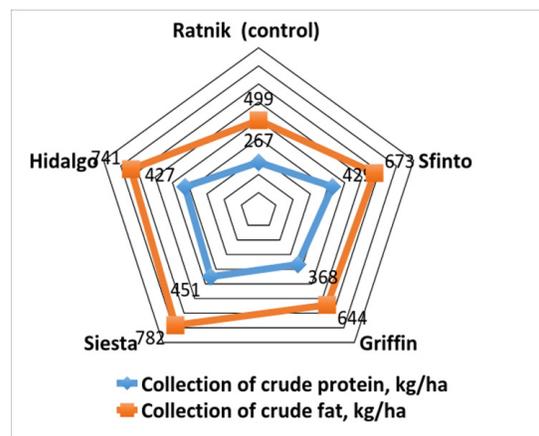


Figure 3. Collection of crude fat and protein with different harvest varieties and hybrids of spring rape, kg/ha (2009-2011).

The highest gross yield of crude protein hybrids are also provided, which is higher than 41 kg/ha in comparison with foreign varieties and 172 kg/ha with a variety of domestic breeding. Grades foreign selection is 1.5 times the gross yield of crude protein in comparison to *Ratnik*.

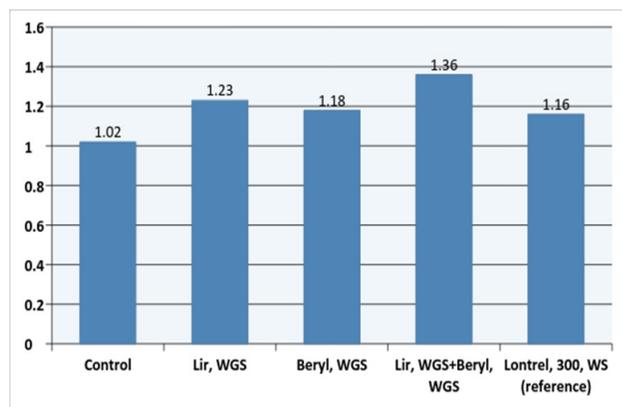
Through years of research botanical composition of weeds in the experiments it was fairly constant and spring rape harvests were about 17 weed species belonging to 11 families: *Chenopodiaceae*, bluegrass, amaranth, bitmap, *Rubiaceae*, *Labiatae*, buckwheat, cabbage, clove, fumaria, *convulvaceae*. The structure of the debris varied with a predominance of young broadleaf weeds by 72.9% in 2009, 50.8%- in 2010 and in 2011- by 52.2%. The number of perennial weeds in the years of research ranged from 6.9 to 27.5%. Among the most persistent weeds grew: catchweed from 4.8 to 15.0%, barnyardgrass from 4.3 to 27.3%, amaranth thrown back from 5.9 to 9.3%, creeping thistle from 2.0 to 11.2%, field bindweed from 4.0 to 8.6%, purple deadnettle from 7.2 to 10.7%.

In spring rape harvests of higher biological (90%), economic (133.3%) and economic (88.9%) showed the effectiveness of herbicide tank mix Lir and Beryl (Table 1.) The number of weeds after application of this mixture was reduced by 90.0%, weight- 83.4%.

Table 1. The biological efficacy of herbicides in spring rape

Option	The number of weeds, pieces/m ²			Reducing the number of weeds% of control		
	After 30 days	After 45 days	Before harvest	After 30 days	After 45 days	Before harvest
K	72.7	53.3	43.0	-	-	-
I	25.3	13.3	9.0	65.2	75.1	78.1
II	26.3	15.0	10.0	63.8	71.9	76.7
III	13.7	8.7	4.3	81.2	83.7	90.0
IV	31.3	17.7	11.7	57.0	66.8	72.8

Additional yield increase was 0.34 t/ha, and the profitability of this method of protecting plants from weeds– 88.9% (Figure 4).

**Figure 4.** Yields of spring rape, depending on the treatment plant herbicides, t/ha.

Individual negative impact studied in the experiment of herbicides on the content of fat and protein in the seeds has been identified. However, it found that the contamination of harvests significantly reduced these figures. The herbicidal oil background gain was 6.4% and 7.2% for protein.

4.2 Assessment of the Aftereffect of Herbicides on the Test Culture Fodder Beet and Soybean

Experience with test cultures showed that in the year following application of herbicides studied permitted the cultivation of sensitive harvests such as fodder beet and soybean.

Reduced biomass beet was within the experimental error. The average weight of the plants had vibrations from

2.874 to 2.880 g. That is, the herbicides are not provided one negative effect on the development of beet.

Because of experiments using soybean, it was found that the length of its minimum observed on seedlings with the herbicide embodiment Lontrel 300 – 18.3 cm, which is lower than the control at 0.4 cm. The use of the herbicide Lir and Beryl mixture Lir + Beryl reduce the length of the seedlings compared to the control at 0.2 cm. Length of soybean after application of the herbicide Beryl was 18.7 cm, as in the control embodiment. Therefore, soybeans as fodder beet, shows a weak sensitivity to the studied herbicides.

4.3 Agronomic Effectiveness of Micronutrients in Spring Rape Cultivation

Studies have shown that all micronutrient fertilizers used in the experiment contributed to increased yields of spring rape, compared with the control.

Less effective was the single treatment plants microfertilizers spring rape in phase outlet. However, as shown by our results that the use of such a period and treatment resulted in increased yield by an average of 0.20-0.69 m/ha.

Single treatment microfertilizers in budding stage provides greater increase in yield from 0.31 to 0.78 t/ha, and the double treatment in phase sockets, followed by a phase of budding contributed the maximum yield increase (0.47-0.94 t/ha).

In general, the use of micronutrients helped to increase the yield of 30.6% (processing phase sockets), 35.1% (processing in the budding stage), 40.0% (processing phase outlets and budding).

Each term treatments highest yield was obtained in the cases where applied micronutrient Plantafol 20:20:20, Plantafol 5:15:45 and strength of life, and the minimum – in the processing plant microfertilizer Boroplyus. However, the maximum increase in the yield was observed in the variant where microfertilizer Plantafol 20:20:20 in worn twice – 0.94 t/ha. The use of this drug has had a significant impact on biometric data: the number of pods per plant increased by 11.5 pc., side shoots – 1.9 pc.

Above the gain from the use of micronutrients complex was in 2009 (0.20-0.95 t/ha) and 2011 (0.22-0.95 t/ha), respectively, and even in the dry summer of 2010, the yield increased micronutrient (0.19-0.90 t/ha).

Studies have shown that a single processing plant

in microfertilizers phase sockets in the budding stage virtually no effect on oil content in seeds. There was only a trend in increasing the fat content at 0.02-0.04%. This oil content in the variants with microfertilizers the average for 2009-2011. It ranged 43.73-43.77% and was at the control level.

Processing of spring rape harvests microfertilizers double – phase outlet, and the phase of budding and tended only to increase the fat content in the seeds. This increase was slight, within 0.03-0.09%. The fat content in the seeds of rape in our research is mainly controlled by the growth conditions. Especially revealing in this respect extreme 2010. Terms evolved this year for the development of spring rape is very unfavourable: the high temperature regime was accompanied by the whole growing season, which was compounded by an acute shortage of water. However, drought conditions have led to an increase in oil content to 44.51-44.61%. According to climatic conditions in 2011, it was close to average, at maturity fell sufficient rainfall (112.4 mm), which had an impact on the fat content in the seeds. Oilseed yield was lower by 1.77% and amounted to 42.75-42.84%. In 2009, the fat content in the seeds vary 43.87-43.95%.

All studied micronutrient fertilizers had a positive impact on the gross harvest of vegetable oil. Minimum noted at the variant without micronutrients, averaged about 479 kg/ha. On versions with microfertilizers, collecting fat was significantly higher. In terms of the phases of the application of an additional fee phase outlet ranged from 87 to 302 kg/ha, in the budding stage- 136-343 kg/ha, in the budding phase socket +- 206-412 kg/ha. However, depending on the type of micronutrients clear trend: The use Plantafol 20:20:20 contributed to a significant increase in collecting fat. In comparison with the control phase outlet additional charge was 302 kg/ha or 63.3%, in the bud stage- 343 kg/ha or 72% with double application- 412 kg/ha or 84.9%. Close results were obtained from the use of Plantafol 5:15:45. This is because these drugs in the structure in addition to trace elements (Boron, iron, manganese, zinc, copper, molybdenum) contained macronutrients: Nitrogen 5-20% phosphorus – 15-20% and 20-45% potassium.

Microfertilizer Boroplyus in all periods of adding gave the lowest growth of fat. In phase outlet compared to Plantafol 20:20:20 shortfall in production was 215 kg/ha, in the budding stage- 207 kg/ha, in the budding phase socket +- 206 kg/ha. This is because the composition of the microfertilizers with zinc, copper and manganese. But

Boroplyus have a significant increase in relation to the control of 18.2 to 42.5%. Other micronutrients (Mikroel, Life Force, Lignohumate) occupy an intermediate position between 20:20:20 and Plantafol Boroplyus.

5. Discussion

Because of the large variety of herbicides, micronutrients and seed, a necessary and important resource in the technology of cultivation of spring rape is the right choice varieties and protection from weeds, and the use of micronutrients in key growth periods of spring rape (active growth of plants during the growing season, the formation of generative organs) helps to increase productivity. The variety of he recommended varieties and hybrids of spring rape allows to select and graded composition that closely matches the characteristics of soil and climatic conditions of cultivation in different regions. In addition, the combined cultivation of early-, mid- and late-ripening varieties and hybrids reduces risk and allows, thanks to the different ripening, optimize cleaning, and reduce losses. The activity of herbicides is defined by their spectrum of action of the dominant structure in agrocenose weeds. Therefore, the selection of drugs in each agro-climatic zone of great importance is the identification of resistant species.

6. Conclusion

Our research has shown that to obtain a high yield, gross yield of oil and protein in the conditions of the Lipetsk region, can be recommended for cultivation of spring rape hybrids foreign Western European breeding Siesta and Hidalgo, grades Sfinto and Griffin, who zoned for 5 regions. In addition, the results of the study herbicide tank mix studied Lear and Beryl was most effective against the weed species such as couch grass, millet, mouse gray, mayweed, knotweed grungy, *Fumaria officinalis*, thistle, and sow thistle field. In addition, the introduction of new herbicides contributed to the increase of productivity as well as it was safe for protected culture. Studies using all kinds of micronutrients helped to improve productivity and increase the gross harvest of fat. In general, the number of collected oil per hectare can be identified microfertilizer Plantafol 20:20:20 when they double treatment of vegetative plants in rosette stage and budding. An essential element in the technology of

cultivation of spring rape is the impact of pesticides on the phytosanitary status of harvests, which will serve the following resources for further research.

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