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Influence of fertilizer and processing of soil on formation of roductivity of spring rape

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The purpose. To study effect of different methods of soil cultivation and doses of fertilizers on formation of productivity of spring rape in conditions of Northern part of Forest-steppe of Ukraine. **Methods.** Field (both visual and phenological observations over growth and development of plants of spring rape), biochemical (determination of quality indicators of seeds), statistical (statistical analysis of results of probes), comparative-calculation (determination of economic and power efficiency of elements of technique of growing spring rape). They carried out experiments according to conventional procedures in farming agriculture and plant growing. Weather conditions during holding probes differed on basic hydrothermal indexes (temperature, rainfall) from average long-term and on years therefore productivity of plants varied a little. **Results.** Results of 2-years (2016, 2017) probes are brought on influence of systems of soil cultivation and fertilizing on productivity of spring rape. **Conclusions.** It is fixed that the highest productivity of seeds (2,24 t/hectare with oil content of 45,78%) was at intense fertilizing in alternative with application of $N_{90}P_{105}K_{120}+N_{30}$ and minimum soil cultivation. Application of technique of straight sowing promotes decrease of power expenditures at growing spring rape and is one of power saving agrotechnical methods (in comparison with conventional cultivation of crop). Importation of fertilizers increases power expenditures at cultivation of rape which attain maximum on the background of $N_{90}P_{105}K_{120} + N_{30}$. Substitution of plowing with disking and importation of fertilizers in dose of $N_{90}P_{105}K_{120} + N_{30}$ at growing spring rape of grade Mahnat is energetically economical alternative because of the highest productivity of seeds, and the greatest receipt of energy with the crop (47040 MJ). The highest quotient of power efficiency was gained in the alternative without fertilizing based on no-till technique (4,45).

Key words: *spring rape, technique of growing, productivity, quality of seeds, fertilizers, soil cultivation.*

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Introduction. A characteristic feature of the development of world agriculture in recent years is the intensive growth in the production of oilseeds. Ukraine is becoming one of the most important producers of oilseeds in the world [1]. The main oilseeds in Ukraine's agricultural enterprises are sunflower, rape and soybeans [2].

During recent years there has been a tendency to expand the sown areas of oilseeds, which is due to the profitability of their cultivation compared with other crops [3]. According to the State Statistics Service of Ukraine in 2017, oilseeds were sown on an area of 9,6 million hectares, while in 2016 – 8,3 million hectares. It should be noted that up to 0,79 million hectares have increased rape area [1].

It is possible to achieve optimum volumes of oilseeds production in Ukraine by increasing the area of sowing while increasing the yield of crops of the cabbage family [4].

As you know, field crops are used for field, field and zero cultivation of soil. Due to the variety of weather conditions and the ground of unanimity, there is no one in the agrarian sector as well as in academics [5].

The purpose of the study is to determine the impact of different methods of soil cultivation and doses of mineral fertilizers on the productivity of rape.

Materials and methods of research. Research on rape spring was carried out in a stationary field field experiment at the Panfilsk research station NSC "Institute of Agriculture of the NAAS" on typical black earths. The content of humus in the soil of Tyurin was at 3,18%, nitrogen was easily hydrolyzed (by

Cornfield) at a low level of 123 mg/kg, phosphorus - 146 and potassium - 102 mg/kg (according to Chirikov), at elevated level security. Reaction of ground solution pH salt. weakly acid – 5,7.

The predecessor of spring rape was barley barley. The size of the sowing area is 150 m^2, the registration is 100 m^2, the repetition of the experiment is three times. Field experiments were laid and executed taking into account the requirements of the experimental research methodology [7].

In the experiment, the rationed varieties of rape were planted by the magnate (the originator of IUU "Institute of Agriculture of the National Academy of Sciences"). Sowing was carried out in the usual routine method with an intermediate row of 15 cm, with the norm of seeding 1,2 million pcs/ha.

The analysis of the quality indices of the seeds by the content of fat in it was carried out by the method of infrared spectroscopy, according to DSTU 4117: 2007 [8], on the infrared analyzer NIP Scanner 4250 p with the computer software ADI DM 3114.

The calculation of the economic efficiency of rape growing was carried out taking into account all costs, production norms, direct and overhead costs as of 1.08.2018.

Energy efficiency of technologies for growing rape, based on different methods of soil cultivation and introduction of mineral fertilizers, was determined according to O.V. Medvedovsky [9].

The subject of the study was the cultivation of soil (**factor A**): 1) shelf; 2) minimal; 3) No-till ("zero" soil cultivation, or "direct sowing" technology); Fertilizer options (**factor B**): 1) without fertilizers (control); 2) $N_{16}P_{16}K_{16}$; 3) $N_{90}P_{60}K_{110}$; 4) $N_{90}P_{105}K_{120} + N_{30}$.

Polygonal cultivation was carried out by plow PLH 3-35 at a depth of 22-25 cm after harvesting barley. In the spring, cultivation was carried out at a depth of 10-12 cm. The pre-sowing cultivation provided for cultivation at a depth of 5-6 cm.

The minimum cultivation provided for autumn peeling in 2 tracks by a disk harrow AG-2,4 at a depth of 10-12 cm. In the spring, cultivation was carried out at a depth of 10-12 cm. The pre-sowing cultivation provided for cultivation at a depth of 5-6 cm.

In the No-till sown areas, Sivas seed drill SZM 3,6 was used for the n-till technology.

The plant protection system included: for the control of weeds (annual dicotyledonous and perennial roots) in the early stages of the development of rape effective introduction of the herbicide of Galera, 33% (0,30 l/ha). Fighting rape pests was carried out on the basis of surveys of crops, while taking into account the economic thresholds for harm.

Meteorological conditions according to the main indicators (temperature, precipitation and distribution during the vegetation period) differed in years of research and on average multi-year indicators. This led to the creation of atypical conditions for the development of rape plants in separate periods of organogenesis, which in different ways influenced the formation of crop productivity, yield and quality of seeds.

In particular, the feature of 2016 was a small amount of precipitation in april and july, and their excessive amount in may and june. Average air temperature during the growing season (april-july) was 17,5 ^oC, which was 2,5 ^oC higher than normal. The amount of precipitation during the growing season was 248 mm, which is 22 mm larger than the average perennial. Relative humidity of air was in the range from 61 to 79%. This year was favorable for growing rape.

Compared to 2016, 2017 was characterized by difficult weather conditions. During the temperature regime, the period of vegetation rape (april-july) was favorable, while for humidity was critical. The average daily air temperature during the growing season was at the standard level and amounted to 15,2 °C, precipitation is 128 mm in the norm of 202 mm. Relative humidity of air was in the range from 58 to 65%.

Research results. Traditional technologies for growing rape are foreseeing the use of intensive mechanical soil cultivation, which leads to deterioration of agrophysical properties and dehumidification and degradation of soils due to erosion processes, which necessitates the introduction of soil protection and minimum soil cultivation methods, and the widespread use of no-till technology.

As a result of the researches it was established that in 2016-2017 the application of the minimized method of basic cultivation leads to increased productivity of rape. In our researches for plowing, the yield of raw rape averaged over the experiment was 1,74 t/ha (table 1).

When replacing conventional plowing by surface treatment, the yield was 1,79 t/ha. Thus, in the case of small disk cultivation, the increase in yield was compared with the work of the shelves by 1,86-7,18%, depending on the fertilizer variant.

According to the no-till technology, the yield of spring rape was the lowest among the studied methods of cultivating the soil and averaged 1,65 tons/ha. Reduced yields for field cultivation was 5,3-7,2%, with a minimum cultivation of 0,6-13,4%.

1. Productivity of rape varieties of durat Magnat depending on the methods of cultivating soil and fertilizer system, t/ha, 2016-2017 gg.

Fertilizer option	Soil processing					
	no-till		minimum		shelf (control)	
No fertilizer (control)	1,23	1,34	1,36	1,23	1,34	1,36
$N_{16}P_{16}K_{16}$	1,63	1,64	1,61	1,63	1,64	1,61
$N_{90}P_{60}K_{110}$	1,80	1,93	1,90	1,80	1,93	1,90
$N_{90}P_{105}K_{120} + N_{30}$	1,94	2,24	2,09	1,94	2,24	2,09
NIR_{05} for the factor: "soil cultivation" – 0,06; Fertilizer system – 0,07.						

The results of the harvest record indicate that the lowest yields of spring rape in the conditions of 2016-2017 were obtained on the control (without fertilization), which at the time of plowing was 1,36 t/ha, for rape sowing in untreated soils using the technology no-till – 1,23 t/ha, and for the minimum soil cultivation – 1,34 t/ha.

The introduction of mineral fertilizers under rape seed crops at a dose of $N_{16}P_{16}K_{16}$ contributed to an increase in yields from the control of 0,13-0,26 t/ha and provided yields of 1,61-1,64 t/ha depending on the soil cultivating system. Balanced nutrition of plants was ensured with the introduction of $N_{90}P_{60}K_{110}$ and $N_{90}P_{105}K_{120} + N_{30}$. So, for the introduction of $N_{90}P_{60}K_{110}$ rape yields reached 1,80-1,93 t/ha, and for $N_{120}P_{105}K_{120}$ – 1,94-2,24 t/ha.

Surface cultivation of the soil better worked for the introduction of increased doses of fertilizers. The highest yield at the level of 2,24 t/ha was obtained during the minimal tillage of the soil at a depth of 10-12 cm, for fertilizer $N_{90}P_{105}K_{120} + N_{30}$.

During the field cultivation of the soil, which provided for plowing, the growth of plant productivity and the formation of higher yields of spring rape seed in the variant with the introduction of $N_{90}P_{105}K_{120} + N_{30}$ was 2,09 t/ha.

Analyzing the results of the research, it can be stated that for cultivating a rape of the ornate Magnate type on black soil, the best agricultural activities are the surface cultivation of soil and the introduction of mineral fertilizers in the dose $N_{90}P_{105}K_{120} + N_{30}$.

The quality of the products we receive for the cultivation of field crops plays an equally important role than yields. The main indicator that determines the quality of rape seeds is the high content and yield of seed oil. The yield of oil from 1 hectare of sown area depends on the oil content of the seed and the level of harvest.

Experimental data indicate that the quality of the rape seed grew more dependent on the background of mineral nutrition than on the methods of basic soil cultivation (table 2).

2. Content of crude oil in spring rape seed and conditional fee per unit area depending on soil cultivation methods and fertilizer systems,%, 2016-2017 gg.

Fertilizer option	Soil processing					
	no-till		minimum		shelf (control)	
	oil content, %	oil yield, t/ha	oil content, %	oil yield, t/ha	oil content, %	oil yield, t/ha
No fertilizer (control)	45,69	0,54	45,59	0,59	45,50	0,59
$N_{16}P_{16}K_{16}$	46,31	0,73	46,14	0,74	46,26	0,73
$N_{90}P_{60}K_{110}$	46,30	0,82	46,13	0,88	45,49	0,84
$N_{90}P_{105}K_{120} + N_{30}$	45,39	0,85	45,78	1,00	44,96	0,91

The oil content in spring rape seed ranged from 44,96 to 46,31%. For plowing this indicator was in the range of 44,96 to 46,26%, while the small cultivation content was 45,78-46,14%, for no-till – 45,39-46,31%.

Maximum indices of oil content in the seeds for the studied tillage systems are indicated on the variant with the application of mineral fertilizers in a dose $N_{16}P_{16}K_{16}$.

The introduction of mineral fertilizers at the doses of $N_{90}P_{60}K_{110}$ and $N_{90}P_{105}K_{120} + N_{30}$ caused a decrease in the oil content of rape varieties up to 44,96 and 45,49% for the field cultivation of the soil, 45.78 and 46.13% for the minimum cultivation and up to 45,39 and 46,30 % for no-till technology.

The research has established that the introduced mineral fertilizers in the experiment and the soil tillage system have influenced the conditional collection of oil per hectare of sowing. The given data suggest that mineral fertilizers increased the conditional oil collection in comparison with the control (without fertilizers) by 0,14-0,32 t/ha against the background of field cultivation of soil, by 0,15-0,41 t/ha against the background of the minimum cultivation and at 0,19- 0,31 t/ha - for zero tillage of the soil. Maximum yield of oil 1,00 t/ha was obtained in variants, where the minimum soil cultivation was carried out and mineral fertilizers were introduced in the dose $N_{90}P_{105}K_{120} + N_{30}$.

In modern conditions of agriculture, an important requirement for the technology elements that are developed and introduced into production is a reduction in the unit cost of production and, as a result, an increase in profits [10].

The analysis of economic efficiency shows that when the depth of soil cultivation is reduced in relation to plowing, material and money costs are reduced for growing rape on 275-285 uah/ha for the minimum tillage system and by 438-450 uah/ha for zero cultivation. Absolute costs for field cultivation of soil for growing rape varied in the range from 5956 to 14639 uah/ha.

The maximum cost was due to the highest fertilizer dose - $N_{90}P_{105}K_{120} + N_{30}$.

The most expensive was the production of 1 ton of seed in the variant, with a zero soil tillage system and the introduction of $N_{120}P_{105}K_{120}$ - 7315 uah.

The maximum level of profitability in the experiment (189%), at the lowest cost (4158 uah/t) and the highest profit (12783 uah/ha) were obtained in the variant with zero treatment of soil and the introduction of mineral fertilizers in a dose $N_{16}P_{16}K_{16}$.

Modern technologies of most agricultural crops are usually quite energy-intensive. One of the ways to reduce the cost of agricultural production is minimizing the cultivation of soil, which is based on reducing the depth of main cultivation and the introduction of small and zero soil cultivation [11].

The most promising technologies include those in which the energy consumption of production is reduced, and the energy efficiency factor, on the contrary, is increased.

In experiments using direct sowing technology, it leads to a reduction in energy costs when growing canola rape to 5802- 19298 MJ/ha, that is, it is an energy-saving agrotechnical technique compared to the generally accepted patchwork of 22-25 cm.

The peculiarity of growing rape is considerable energy. At the same time, the use of less energy-intensive disk implements resulted in a decrease in the amount of energy expended in the cultivation of spring rape up to 7316-20824 MJ/hectare, while the use of fixed assets amounted to 7962-21462 MJ/ha.

According to the data, the energy consumption was the lowest in the case of non-fertilizers - 5802-7962 MJ/ha, as well as in the version where only $N_{16}P_{16}K_{16}$ was introduced - 7866-10021 MJ/ha. In variants with the introduction of high doses of fertilizers, they increased to 16017-21462 MJ/hectare and depended on the cultivation of soil.

The highest technological costs were in the version with fertilizer application $N_{90}P_{105}K_{120} + N_{30}$.

The calculation of energy efficiency from the application of different doses of mineral fertilizers showed that the highest energy per hectare was received when applying mineral fertilizers $N_{90}P_{105}K_{120} + N_{30}$ - 40,740 MJ for zero tillage, 43890 for the shelf and 47040 for the minimum cultivation.

It was established that the highest indicator of the energy efficiency factor for growing rape varieties of Magnat type was observed in the technology of soil cultivation no-till - 2,11-4,45.

For plowing, there was a decrease in the energy efficiency coefficient to 2,05-3,59, for a minimum cultivation - up to 2,26-3,85.

The maximum values of the energy coefficient reached the variants with the least energy consumption (without fertilizers), which indicates the energy savings in growing rape in these variations of the experiment.

The introduction of the studied doses of mineral fertilizers in the cultivation of rape yielded an increase in the absolute values of energy output, but at the same time, it caused an increase in its costs for the formation of seeds and a reduction in the energy efficiency.

Conclusions

Yield of rape depended on the methods of basic soil cultivation and fertilization. Based on the results of field studies, it has been established that minimal cultivation and mineral fertilizers create more favorable conditions for the formation of a rape crop. The highest yield of spring rape – 2,24 t/ha and the maximum yield of oil per 1 hectare of crop – 1,00 t/ha was achieved for minimal tillage with the application of mineral fertilizers in a dose of $N_{120}P_{105}K_{120}$ kg/ha.

In the conditions of 2016-2017, the most effective system for the basic cultivation of the soil, which included zero cultivation, as well as fertilizer, which involved the introduction of $N_{16}P_{16}K_{16}$, was the most effective for growing rape. For this variant cultivation received the highest level of profit, the lowest cost of seeds and the highest level of profitability.

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