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OPTIMIZATION OF THE MINERAL NUTRITION CONDITIONS OF MUSTARD

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Abstract

The article gives an assessment of one of the promising and valuable oilseeds - mustard, the cultivation of which is provided by the program of diversification of grain production in Kazakhstan, in particular, crop production. It was revealed that the conditions of mineral nutrition of mustard in the steppe zone of Northern Kazakhstan were not studied.

Therefore, experiments were laid to study the optimization of the conditions for the mineral nutrition of mustard. A 14-variant scheme was presented to create different levels of phosphorus and nitrogen in the soil in order to determine the quantitative connection between the level of nutrients in the soil and the productivity of mustard varieties.

The purpose of the research (2019-2021) was to study the features of mineral nutrition and fertilizer of mustard in the conditions of the steppe zone of Northern Kazakhstan. Their main directions were: to study the requirements of this crop to the level of fertility and soil properties; study the properties of the soil and determine its ability to meet the needs of crops.

The conclusions of the research suggest that in all year's mustard has developed under conditions of phosphorus deficiency in the soil, an average supply of nitrogen, and an increased supply of potassium. The application of nitrogen-phosphorus fertilizers contributed to an increase in the content of nitrogen, nitrates and mobile phosphorus in the soil by 2-3 times and was determined by the amount of fertilizers applied.

The productivity of mustard on a natural unfertilized background was low, and it depended on the dose of fertilizers, soil moisture, and the initial content of nutrients. This explains the ambiguous reaction of mustard to the application of the same types, doses and combinations of fertilizers.

Key words: mustard; southern chernozem; nitrate nitrogen; mobile phosphorus; mineral fertilizers; productivity.

Introduction

The concept of agro-industrial complex of the country includes a complex that combines all sectors of the national economy for the production and delivery of agricultural products to the consumer. Agriculture provides the population of the country with food, and industry with the necessary raw materials [1]. To improve the economic efficiency of the country's agricultural production, the project "National Project for the Development of the Agro-Industrial Complex in Kazakhstan in 2021-2025" was developed [2].

To solve the problem of crop diversification in the crop industry, many agricultural producers included in the crop rotation crops with high demand in the market of Kazakhstan and the world [3]. One of these crops are oilseeds, which due to their marginal cost farmers show high demand and every year the area under them grows. In 2022 compared to 2021, the area of oilseeds increased by 18,2% (2022 – 3463,4 thousand hectares) [4].

Mustard is one of the valuable oilseeds, which is used as a universal material for a comprehensive direction, in the processing of agricultural products (obtaining fatty oils, essential oils, cake powder), in medicine (vitamins, anti-inflammatory patches), processing of biofuels for transport, etc [5]. In Kazakhstan, mustard it is widely cultivated in Akmola, Karaganda, Kostanay, Pavlodar, North Kazakhstan and East Kazakhstan regions.

It is unpretentious in cultivation, little demanding to soil and climatic conditions, little susceptible to diseases and pests [6].

The consumption of nutrients from the soil, their accumulation in plants and their removal with the harvest is directly dependent on the productivity of crops, which is largely determined by the provision of field crops with mineral nutrition elements [7].

Responsiveness of mustard plants to fertilizer application in the soil is important in the study of its mineral nutrition. In relation to soil fertility, the content of nutrients in the soil mustard is extremely responsive and therefore the application of mineral fertilizers helps to achieve sustainable high yields [8,9,10].

Currently, an extensive material of domestic and foreign researchers has accumulated that prolonged application of fertilizers, especially mineral fertilizers, changes many of its properties.

Thus, ongoing researches on the application of mineral fertilizers under crops of mustard, which indicate the formation of high yields of culture [11,12,13]. Initial supply of soil elements affects its productivity, and with the application of mineral fertilizers, it changes depending on the dose of fertilizers [14].

Optimizing the conditions of mineral nutrition means providing plants with all the necessary elements for its life and not only in the required amount, but also in the ratio.

Different cultures, due to their biological characteristics, require different levels of soil saturation with nutrients. The ability of soils to meet the needs of plants in nutrients, water and other factors of plant vital activity is its main advantage as an indicator of fertility. The lack or excess of elements leads to an imbalance in nutrition, which negatively affects the productivity and quality of crops [15].

Creation of optimal conditions for plant nutrition allows realizing the genetic potential of the variety and getting the highest possible productivity in the emerging conditions.

Each soil has its own fertility indicators: the quantitative content and composition of humus, its biological activity, agronomic, water, physical, chemical, physicochemical, mineralogical and other properties that not always and not fully meet the requirements of crops.

In this regard, to optimize the nutrition of a particular crop is necessary:

- to study the requirements of a given crop to the level of fertility and soil properties;
- to study the properties of the soil and determine its ability to meet the needs of crops;
- to develop methods for regulating soil fertility in order to create the necessary nutritional conditions.

This set of questions based on long-term data is well worked out for cereals [16] and some other crops [17].

On the example of grain crops, the main factors determining the productivity of crops were determined. These are humus, the content of available forms of nitrogen, phosphorus, potassium, pH, Ca, Mg, moisture supply [18]. For mustard, similar studies have not been conducted before. They were the basis for research on mustard.

Materials and methods

The research was conducted in 2019-2021 in the conditions of “Nikolskoe” LLP of Bulandy district of Akmola region, located in the steppe zone of Northern Kazakhstan.

The soil cover of the site is represented by southern carbonate chernozem. The thickness of the humus horizon of soils is 45-47 cm. The content of humus is 3,8%, the content of total nitrogen is 0,25-0,30%, mobile phosphorus is 15-20 mg/kg, potassium is 35-50 mg/100 g of soil. The soil solution reaction is 8,0-8,1.

The experiments were laid according to 14 variant scheme, in triple replication, where 7 levels of phosphorus (0; P60; P90; P120; P150; P180; P210), 3 nitrogen (0; N30; N60) and 5 paired combinations (P90N30; P60N60; P120N60; P120N90; P150N90) were studied. Ammonium nitrate (34,6%) was used as nitrogen fertilizer, of phosphorus fertilizer - ammophos (52% P2O5, 11-12% N).

Agronomic techniques in the experiments were generally accepted for the zone. Phosphorus

fertilizers were applied in autumn to a depth of 18-20 cm. Mustard was sown with Bourgault 3710 seeding complex. Seed rate was 10 kg/ha. The variety Rushena was sown [19].

The area of one plot is 54 m2 (12x4,5m). All technological operations were carried out mechanized, except for yield accounting.

Results

Meteorological conditions during the years of research differed significantly from each other, Table 1.

Table 1 - Characteristics of weather conditions during the growing season

Years	Precipitation, mm					Average daily air temperature, ºC				
	months									
	May	June	July	August	for V-VIII	May	June	July	August	for V-VIII
Average	37,0	37,0	66,0	37,0	177,0	12,7	18,3	19,5	17,5	17,0
2019	7,0	16,8	45,0	34,0	102,8	11,7	15,7	19,9	17,9	16,3
2020	2,6	54,9	58,8	26,3	142,6	16,3	17,5	19,4	18,8	18,0
2021	59,0	19,0	8,0	15,0	101,0	17,5	17,4	19,9	19,7	18,6

In terms of precipitation, all years were dry and extremely unevenly distributed over months and periods. The lack of precipitation was observed during the growing season of the crop, which strongly affected the growth and development of plants. During the growing season, in total, according to long-term average data, out of 177 mm of precipitation in 2019, only 102 mm fell, the shortfall was more than 70 mm (58% of the norm). More favorable and close to the average annual norm were June and July months (113,7 mm of precipitation) in 2020 despite the lack of precipitation for the month of May (2,6 mm), which subsequently had a positive impact on plant growth and development.

The year 2021 was acutely dry, where only 42 mm of rain fell in June-August, which was 98 mm less than normal. Lack of heat in spring and summer period was characteristic for them.

The average daily air temperature exceeded the long-term average in 2020 and 2021 at 1.0-1.60C. In the period from the beginning of the rosette phase to the full ripeness of mustard, precipitation fell in insignificant amounts, which, combined with high daytime temperatures, led to a deterioration in plant nutrition and, subsequently, to the formation of low grain content (many empty pods).

Productive moisture reserves in the 2019-2021-meter profile were 169,0, 179 and 131,0 mm, respectively.

Meteorological conditions significantly affected both soil processes and the characteristics of plant growth and development, the formation of mustard crops.

Conditions of soil nutrition in the years of research were different. Table 2 shows the initial content of nutrients in the soil before sowing mustard.

Table 2 - Dynamics of nutrients in the soil before sowing mustard

Soil layer, cm	$N\text{-}NO_3$, mg/kg			P_2O_5, mg/kg			K_2O, mg/100 g		
	Years of research								
	2019	2020	2021	2019	2020	2021	2019	2020	2021
0–20	13,0	14,5	14,1	20,5	19,3	17,1	580	571	562
20-40	8,6	9,1	8,60	7,7	8,5	7,9	433	443	453
0-40	10,8	11,8	11,3	14,1	13,9	12,5	507	507	508
40-60	7,0	8,9	5,7	3,3	4,0	3,3	332	333	335
60-80	5,0	5,6	2,2	2,1	2,0	2,3	215	312	208
80-100	2,8	4,3	1,3	1,1	1,0	1,8	206	205	203

As can be seen from the table, in all years, mustard developed under conditions of a deficiency of phosphorus in the soil, an average supply of nitrogen, and an increased supply only of potassium.

Application of nitrogen-phosphorus fertilizers increased the content of nitrate nitrogen and mobile phosphorus in the soil by 2-3 times and was determined by the amount of fertilizer applied (Table 3).

As a result, in experiments by variants there was different provision of mustard with nitrogen and phosphorus. Both the content and the ratio of nutrition elements depended on the amount of fertilizer applied. Nitrate nitrogen played the main role in nitrogen nutrition. The content of ammonia nitrogen in the years of research depended mainly on climatic conditions and already in the initial stage of plant development there was no ammonia nitrogen in the soil, which can be explained on the one hand by its possible absorption by plants, and on the other hand by active nitrification [20]. The nitrogen content of nitrates in the variants varied from 9,9 to 16,8 mg/kg of soil, and of mobile phosphorus from 18,3-20,0 in the control to 37,6-44,1 mg/kg in the fertilized variants.

Table 3 - Influence of fertilizers on the content of nutrients in the soil before sowing mustard, mg/kg

Applied	Years of research			
	2019	2020	2021	Average
	$N\text{-}NO_3$ content in the 0-40 cm layer			
O	9,9	13,7	11,9	11,8
N30	12,1	15,6	13,7	13,8
N60	13,5	16,8	14,2	14,8
P_2O_5 content in the 0-20 cm layer				
O	20,0	21,0	18,3	19,4
P60	26,7	26,8	22,0	26,0
P90	29,3	31,7	25,6	28,4
P120	36,0	36,9	28,4	33,5
P150	39,7	39,4	31,9	36,9
P180	40,1	42,7	35,4	35,8
P210	44,1	46,2	37,6	40,9

Moisture and soil nutrition conditions were reflected in the productivity of mustard, Table 4. As can be seen from the table, mustard productivity especially on natural unfertilized background in the years of research was low. There are several reasons - low level of moisture and mineral nutrition. Efficiency of fertilizers was different and depended on a number of factors. The most important of which were - moisture availability, the initial content of nutrients in the soil before sowing and their balance, which in the years of research were also different. This explains the ambiguous response of mustard to the application of the same types, doses and combinations of fertilizers.

The highest productivity of mustard on the control and its responsiveness to fertilizers was noted in 2019, despite the deficit of phosphorus in the soil. The determining factor this year was not so much the amount of rainfall during the growing season (102 mm) as their distribution. In May-June, monthly precipitation did not exceed 23 mm, while July-August was within normal limits. Plants survived mainly due to spring moisture reserves – 169,0 mm in a meter layer.

The most effective in 2019 were phosphate fertilizers. The best result was obtained with the P180 dose, the increase was 75,6% compared to the control. This is the best indicator for all years.

Under conditions of drought, due to the lack of productive moisture, nitrogen fertilizers did not work. It should be noted that the content of N-NO3 in the soil played an important role; it was sufficient for the formation of the mustard crop.

Table 4 - Influence of nitrogen-phosphorus fertilizers on the productivity of mustard, c/ha

Applied	Controlled harvests and additions to it							
	2019		2020		2021		average over 3 years	
	c	%	c	%	c	%	c	%
0	14,1	100	13,1	100	11,7	100		
N30	-0,1	99,3	-0,5	96,2	1,8	115,4	0,4	103,1
N60	-0,3	97,9	-0,3	97,7	2,6	122,2	0,6	104,6
P60	5,6	139,7	4	130,5	3	125,6	4,2	132,3
P90	6,3	144,7	6,7	151,1	4,1	135,0	5,7	143,8
P120	6,5	146,1	6,5	149,6	4,3	136,8	5,7	143,8
P150	6,6	146,8	8	161,1	5,4	146,2	6,6	150,8
P180	6,3	144,7	9,9	175,6	5	142,7	7	153,8
P210	3	121,3	5,4	141,2	4,7	140,2	4,3	133,1
P90 N30	12,2	186,5	15,3	216,8	7,9	167,5	11,8	190,8
P60 N60	10,5	174,5	10,5	180,2	6,4	154,7	9,1	170,0
P120 N60	8,1	157,4	12,6	196,2	8,9	176,1	9,8	175,4
$НСР_{05}$	0,52		2,3		1,2		1,3	
m%	0,18		0,80		0,42		0,5	

In 2021, at the initial content of P2O5 in the soil layer 0-20 cm, the highest gain of 5,4 c/kg, or 46,2% compared to the control, was obtained after application of P150, where P2O5 content was 31,9 mg/kg of soil. Increasing P2O5 content in the soil to 37,6 mg (at application of P210) reduced the increase in mustard yield from 5,4 to 4,7 c, or from 46 to 40% of the control.

The effectiveness of paired combinations varied from year to year and was determined by the same factors, i.e. initial content and ratio of elements.

Studies show that mustard, like other crops, requires a certain level of soil saturation with nutrients, which can be achieved by applying fertilizers with the obligatory consideration of the initial content of elements in the soil. In this regard, completely groundless attempts of some researchers to find the most effective - "universal" (or rather template) dose of fertilizer for this crop in all cases.

Between the content of nutrients in the soil and mustard yield a certain quantitative relationship has been established, which allows us to determine the optimal parameters of the basic agrochemical properties of the soil.

The greatest variability under the influence of weather and agrotechnical factors was the content of moisture in the soil, mineral nitrogen and mobile phosphorus to a greater extent determining the formation of the yield. Other factors (pH, Ca, Mg, and even humus) had less influence on the yield due to slight variation within the experiment. But they also play an important role, as evidenced by their high correlation coefficient with yield. Thus, the highest mustard yield in the experiment was formed at pH 7,8 (R=0,71), the content of Ca and Mg at 21,6-21,9 mg-eq/100 g of soil at R=0,79. With the content of productive moisture before sowing mustard in the layer 0-100 cm correlation coefficient did not exceed 0,61 and in some years the connection was insignificant despite the great importance of this factor. This can be explained by the fact that not only spring moisture supply plays an important role for yield formation, although it is very important, but also the degree of moisture of the growing season, the amount and character of distribution of precipitation. Precipitation of the month of July plays a particularly important role.

The highest and strongest relationship of productivity is established with the content of mobile phosphorus in the soil, Figure 1-4.

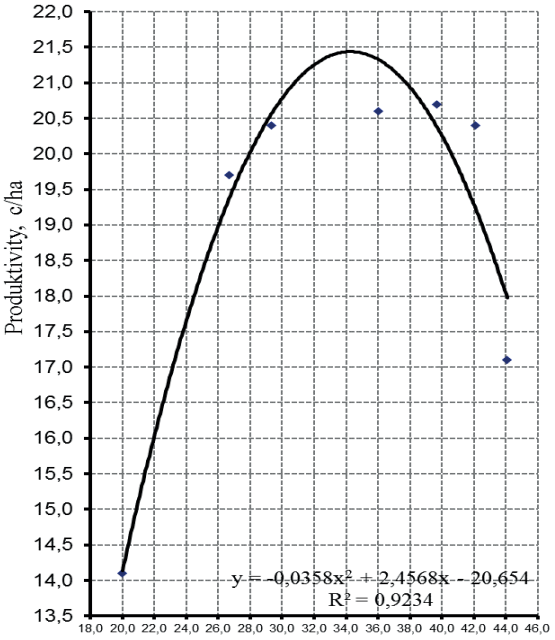

Рисунок 1 - Связь урожайности горчицы сорта Рушена с P2O5 в почве, 2019 г., R=0,98

Figure 1 – Yield relationship of mustard Rushena variety with P2O5 in soil, 2019, R=0,92

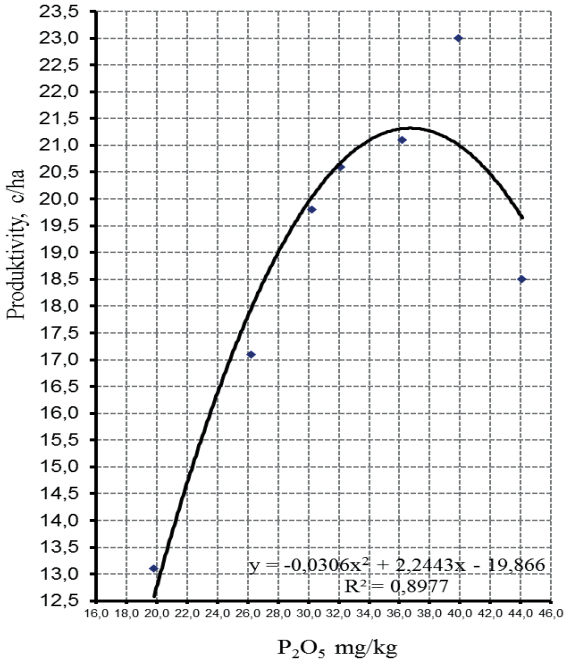

Рисунок 2 - Связь урожайности горчицы сорта Рушена с P2O5 в почве, 2020 г., R = 0,93

Figure 2 - Yield relationship of mustard Rushena variety with P2O5 in soil, 2020, R=0,90

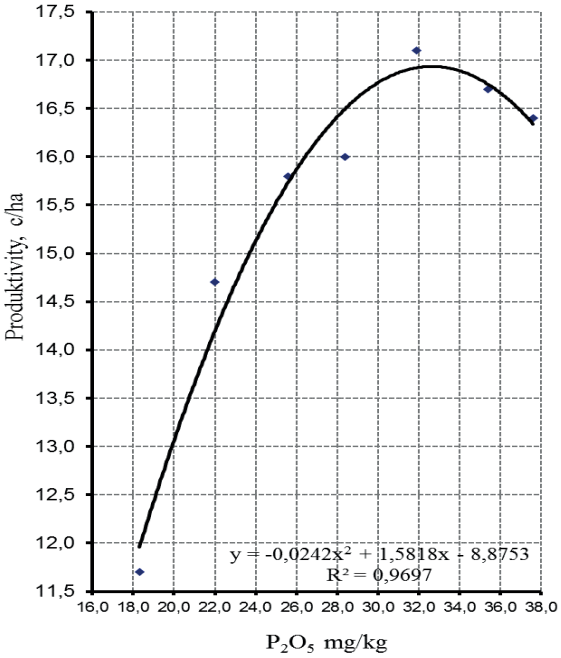

Рисунок 3 - Связь урожайности горчицы сорт Рушена с P2O5 в почве, 2021 г., R=0,98

Figure 3 - Yield relationship of mustard Rushena variety with P2O5 in soil, 2021, R=0,97

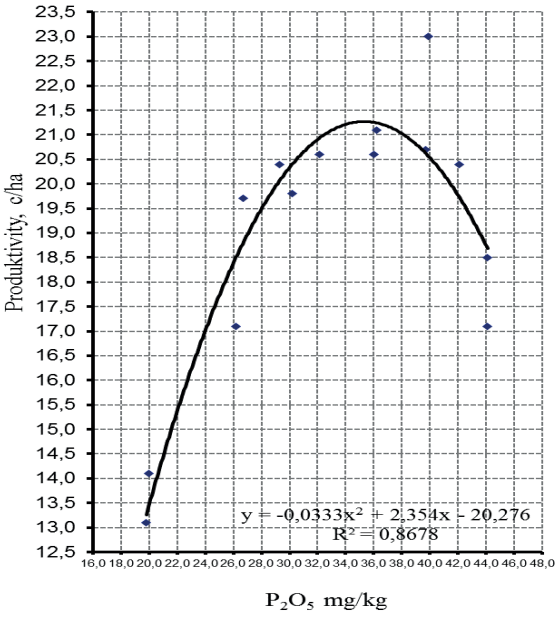

Рисунок 4 - Связь урожайности горчицы сорт Рушена с P2O5 в почве, за 2019-2020 гг., R=0,92

Figure 4 - Yield relationship of mustard Rushena variety with P2O5 in soil, 2019-2020, R=0,87

We found a close correlation (R=0,92, 2019) of mustard productivity with the content of mobile phosphorus in the soil before sowing, Figure 1.

Under the conditions of 2020, Figure 2, the highest yield of 20,5 centners was formed with P2O5 content in the 0-20 cm layer was at the level of 32 mg/kg of soil, and in 2021 - also on the background of 32 mg, Figure 3. To increase phosphorus content from 32 to 36 mg/kg (peak) requires 40 kg of ammophos, which gives an increase in mustard yield to only 1 c/ha, which is not economically justified. Therefore, the optimum is determined not by the peak, but by the level that is economically justified.

From the given data, it is obvious that the optimal level of mobile phosphorus content in the 0-20 cm layer is at the level of 30-32 mg, which can be seen from Figure 4 for the combined indicators of 2019-2020. In the conditions of 2021, despite the dry year, a high correlation coefficient and a high yield increase from P150 were also obtained from the background of 32 mg P2O5.

The level of 42,7 mg/kg P2O5 in the soil, created in 2020 by the dose of P180, was excessive for mustard, despite receiving a 9,9-quintal yield increase, which is not compensated for by the cost of fertilizing. A clear decrease in yield can be seen in Figures 2 and 4. The content of P2O5 above 36 mg/kg of soil further reduces the cost recovery of mustard. Under the conditions of the dry steppe zone, 32 mg/kg should be considered as the upper level of the optimal P2O5 content for mustard.

The optimum content of mobile phosphorus in the soil was determined at the level of 30-32 mg/kg of soil.

The latter is confirmed as the results of the action of fertilizers, as mentioned above, and the correlation and regression analysis. Determination of optimum levels of phosphorus and nitrogen in the soil allows with high accuracy, using already known formulas (V.G.Chernenok, 1989): Dr = (Popt - Pfact)*10, to calculate the dose of fertilizers that must be applied in order to create optimal conditions for mineral nutrition of mustard for the formation of a potential crop in the prevailing conditions of moisture. When calculating fertilizer doses, it is advisable to use the lower limit of the optimum.

Discussion

As a result of scientific research, the optimal doses of mineral fertilizers were determined for the cultivation of mustard in the conditions of the steppe zone of North Kazakhstan in order to increase productivity and increase the competitiveness of crop products in the domestic and foreign markets.

Mustard is demanding on the conditions of mineral nutrition in the soil. Assessing the availability of soils with available forms of plant nutrients is a great importance for developing the most optimal system for applying fertilizers and obtaining the maximum economic return. Therefore, it is important to evaluate plant nutrients that take part in the main functions of the plant organism and note that they do not all absorb them equally from soil and fertilizers. This must be taken into account when applying mineral fertilizers.

The researches carried out on the southern chernozems of the steppe zone showed that mustard, based on biological and genetic characteristics, impose certain requirements on the conditions of mineral nutrition in the soil, which is also confirmed by scientific researches in Canada (Alberta and Saskatchewan) and Russia in almost at the same soil and climatic conditions [21, 22]. To determine the optimal level of nutrients in the soil and how to achieve it, it is necessary to realize the maximum potential of the crop.

Conclusions

According to the results of research, it was found that there cannot be a certain identical dose of mineral fertilizers for mustard, which would be guaranteed to give a high result in any conditions. In each case, it is individual and the best result is given by the dose that can bring the content of nutrients in the soil to the optimal level. Mineral fertilizers with optimal application, taking into account the content of nutrients in the soil, give a significant increase in mustard yield.

In these researches, for the first time in the conditions of the steppe zone of Kazakhstan, was revealed:

- mustard yields were directly dependent on climatic conditions, in particular, on the amount of precipitation and reserves of productive moisture in the soil;

- it was noted that the arid climate of the steppe zone of Kazakhstan is not an obstacle to obtaining a fairly stable crop of mustard seeds when fertilizing

- with a low content of phosphorus in the soil, the doses of phosphorus fertilizers affected the yield of mustard. For example, in 2019, the best indicator for all years was obtained for the dose of P180, the increase was 75.6% compared to the control.

- a strong degree of correlation was established between the yield of mustard plants and the phosphorus content in the soil, for the Rusheny variety, the optimal level of mobile phosphorus content in the 0-20 cm layer is at the level of 30-32 mg, according to the combined indicators of 2019-2020, which, perhaps, the biological characteristics of mustard have changed.

References

1 https://articlekz.com/article/21172

2 https://adilet.zan.kz/rus/docs/P2100000732/history

3 https://adilet.zan.kz/rus/docs/P2100000960

4 Specified sown area of oilseeds. [Text] / Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. https://stat.gov.kz/official/industry/14/statistic/7

5 Karlson D. Targeted mutagenesis of the multicopy myrosinase gene family in allotetraploid brassica juncea reduces pungency in fresh leaves across environments [Text]/ Karlson D., Mojica J. P., Poorten T. J., Lawit S. J., Jali S., Chauhan R. D., Rapp R. // Plants, - 2022. - № 11(19). – C.92-94.

6 Medvedev G.A. Mustard [Text]: Medvedev G.A., Mikhalkov D.E., Ekaterinichev N.G. // Monograph. Volgograd: FSBEI HE Volgograd State Agrarian University. - 2012. – 152 p.

7 Shatilov I.S. Rotation Nutrient Balance and Field Crop Yield Programming [Текст] / Shatilov I.S. [and other] // Programming crop yields crops. – Kazan: Tatar book publishing house. - 1984. – P. 31 – 40.

8 Seema Sahay, Modulation in growth, photosynthesis and yield attributes of black mustard (B.nigra cv. IC247) by interactive effect of wastewater and fly ash under different NPK levels [Text] / Seema Sahay, Akhtar Inam, Arif Inam & Saba Iqbal // Cogent Food & Agriculture. – 2015. - Vol 1. Issue 1.: 1087632.

9 Parihar C. M., Energy scenario, carbon efficiency, nitrogen and phosphorus dynamics of pearlmillet – mustard system under diverse nutrient and tillage management practices [Text] / Parihar C. M., Bhakar R. N., Rana K. S., Jat M. L., Singh A. K., Jat S. L., Parihar M. D., Sharma S. // African Journal of Agricultural Research. – 2013. - Vol. 8(10). - P. 903-915.

10 Singh S.B. Effects of phosphorus and sulphur fertilization on yield and nps uptake by mustard (Brassica juncea L.) [Text] / Singh S.B., S.B. Thenua O.V.S. // Progressive Research – An International Journal. – 2016. – Vol. 11 (1). – pp. 80-83

11 Vassilina T. Some aspects of mineral and organic nutrition for improved yield and oil contents of mustard (Brassica juncea) [Text] / Vassilina, T., Umbetov, A., Cihacek, L. J., & Vassilina, G. // Eurasian Chemico-Technological Journal. – 2012. – Vol. 14(3). – P. 263-269.

12 Melnyk A. Impact of foliar fertilizing on the white mustard productivity in the northeastern Forest-Steppe of Ukaraine [Text] / Melnyk, A., Zherdetska, S., Ali, S., Shabir, G., & Butenko, S. // Bulletin of Sumy National Agrarian University. The Series: Agronomy and Biology. – 2019. - Vol. 3(37). – P. 24-28.

13 Borodychev V.V., Innovative methods of cultivation of Sarepta mustard in the system of rice crop rotation [Text] / Borodychev V.V., Lytov M.N., Tsybulin V.// Proceedings of the Nizhnevolzhsky AgroUniversity Complex. – 2013. - № 4 (32). – P. 8-12.

14 Vinogradov D.V. Productivity of mustard depending on the level of mineral nutrition [Text] / Vinogradov D.V. // Vestnik RGATU. – 2009. - №3. – P. 39-42.

15 Parvaiz M.A. Mineral nutrition of mustard [Text] / Parvaiz M.A. // Abstract thesis submitted to the Aligarh Muslim University, Aligarh, in Partial Fulfilment of the Requirements for the Degree of. Doctor of philosophy in botany, Shodhganga: a reservoir of Indian theses @ inflibnet. – 2015. – P. 145.

16 Chernenok V.G. The influence of the systematic application of fertilizers in crop rotation on the fertility of grain crops with intensive technologies for their cultivation [Text] / Chernenok V.G.

// Proceedings of VIUA: The use of fertilizers and the expansion of the reproduction of soil fertility. Moscow. – 1989. - C. 119-122.

17 Chernenok V.G. The effectiveness of nitrogen-phosphorus fertilizers on dark chestnut soils of Central Kazakhstan, depending on the level of soil phosphorus supply [Text] / Chernenok V.G., Savinova R.M., Sadovenko Yu.I. // Proceedings of the Tselinograd Agricultural Institute: Ways to increase the intensification of grain production in Northern Kazakhstan. Tselinograd.- 1987. – P.3-9.

18 20 Chernenok V.G. Scientific bases and practical methods of managing soil fertility and crop productivity in Northern Kazakhstan [Text]: Chernenok V.G. // Astana.- 2009. – 66 p.

19 21 State Register of Breeding Achievements Recommended for Use in the Republic of Kazakhstan [Text] / Nur-Sultan. – 2019. - 99 p.

20 Chernenok V.G. Nitrogen regime of soils in Northern Kazakhstan and the use of fertilizers [Text]: Chernenok V.G. // Akmola. - 1997. – 91 c.

21 Mustard Production for Alberta. [Text] / Practical information for Alberta's agriculture industry. - January 2010. - Agdex 143/20-1. – 14 p.

22 Radchenko V.I. Influence of mineral fertilizers on the formation of the yield of Sarepta mustard on ordinary chernozem [Text]: Radchenko V.I. // Thesis.cand. s.-x. Sciences: 06.01.09: Saratov. - 1999. - 190 p.

Список литературы

1 https://articlekz.com/article/21172

2 https://adilet.zan.kz/rus/docs/P2100000732/history

3 https://adilet.zan.kz/rus/docs/P2100000960

4 Уточненная посевная площадь масличных культур. [Текст] / Бюро национальной статистики Агентства по стратегическому планированию и реформам Республики Казахстан. https://stat.gov.kz/official/industry/14/statistic/7

5 Karlson D. Targeted mutagenesis of the multicopy myrosinase gene family in allotetraploid brassica juncea reduces pungency in fresh leaves across environments [Text] / Karlson D., Mojica J. P., Poorten T. J., Lawit S. J., Jali S., Chauhan R. D., Rapp R. // Plants, - 2022. - № 11(19). – P.92-94.

6 Медведев Г.А. Горчица [Текст]: Медведев Г.А., Михальков Д.Е., Екатериничева Н.Г. // Монография. Волгоград: ФГБОУ ВПО Волгоградский ГАУ. - 2012. – 152 с.

7 Шатилов И. С. Баланс питательных веществ в севообороте и программирование урожаев полевых культур [Текст] / И. С. Шатилов [и др.] // Программирование урожаев с.-х. культур. – Казань: Татарское книжное изд-во. - 1984. – С. 31 – 40.

8 Seema Sahay, Modulation in growth, photosynthesis and yield attributes of black mustard (B.nigra cv. IC247) by interactive effect of wastewater and fly ash under different NPK levels [Text] / Seema Sahay, Akhtar Inam, Arif Inam & Saba Iqbal // Cogent Food & Agriculture. – 2015. - Vol 1. Issue 1.: 1087632.

9 Parihar C. M., Energy scenario, carbon efficiency, nitrogen and phosphorus dynamics of pearlmillet – mustard system under diverse nutrient and tillage management practices [Text] / Parihar C. M., Bhakar R. N., Rana K. S., Jat M. L., Singh A. K., Jat S. L., Parihar M. D., Sharma S. // African Journal of Agricultural Research. – 2013. - Vol. 8(10). - P. 903-915.

10 Singh S.B. Effects of phosphorus and sulphur fertilization on yield and nps uptake by mustard (Brassica juncea L.) [Text] / Singh S.B., S.B. Thenua O.V.S. // Progressive Research – An International Journal. – 2016. – Vol. 11 (1). – P. 80-83

11 Vassilina T. Some aspects of mineral and organic nutrition for improved yield and oil contents of mustard (Brassica juncea) [Text] / Vassilina, T., Umbetov, A., Cihacek, L. J., & Vassilina, G. // Eurasian Chemico-Technological Journal. – 2012. – Vol. 14(3). – P. 263-269.

12 Melnyk A. Impact of foliar fertilizing on the white mustard productivity in the northeastern Forest-Steppe of Ukaraine [Text] / Melnyk, A., Zherdetska, S., Ali, S., Shabir, G., & Butenko, S. // Bulletin of Sumy National Agrarian University. The Series: Agronomy and Biology. – 2019. - Vol. 3(37). – P. 24-28.

13 Бородычев В.В. Инновационные приёмы возделывания горчицы сарептской в системе рисового севооборота [Текст] / Бородычев В.В., Лытов М.Н., Цыбулин В. // Известия Нижневолжского агроуниверситетского комплекса. – 2013. - № 4 (32). – С. 8-12.

14 Виноградов Д.В. Продуктивность горчицы в зависимости от уровня минерального питания [Текст] / Виноградов Д.В. // Вестник РГАТУ. – 2009. - №3. – С. 39-42.

15 Parvaiz M.A. Mineral nutrition of mustard [Text] / Parvaiz M.A. // Abstract thesis submitted to the Aligarh Muslim University, Aligarh, in Partial Fulfilment of the Requirements for the Degree of. Doctor of philosophy in botany, Shodhganga: a reservoir of Indian theses @ inflibnet. – 2015. – P. 145.

16 Черненок В.Г. Влияние систематического внесения удобрений в севообороте на плодородие зерновых культур при интенсивных технологиях их возделывания [Текст] / Черненок В.Г. // Труды ВИУА: Применение удобрений и расширение воспроизводство плодородия почв. - Москва. – 1989. - С. 119-122.

17 Черненок В.Г. Эффективность азотно-фосфорных удобрений на темно-каштановых почвах Центрального Казахстана в зависимости от уровня обеспеченности почв фосфором [Текст]/ Черненок В.Г., Савинова Р.М., Садовенко Ю.И. // Труды Целиноградского СХИ: Пути повышения интенсификации производства зерна в Северном Казахстане. - Целиноград. - 1987. – С.3-9.

18 Черненок В.Г. Научные основы и практические приемы управления плодородие почв и продуктивностью культур в Северном Казахстане [Текст]: Черненок В.Г. // - Астана. - 2009. – 66 с.

19 Государственный реестр селекционных достижений, рекомендуемых к использованию в Республике Казахстан [Текст]: - Нур-Султан. – 2019. - 99 с.

20 Черненок В.Г. Азотный режим почв Северного Казахстана и применение удобрений [Текст] / Черненок В.Г. / - Акмола. - 1997. – 91 с.

21 Mustard Production for Alberta. [Text]: Practical information for Alberta's agriculture industry. - January 2010. - Agdex 143/20-1. – 14 с.

22 Радченко В.И. Влияние минеральных удобрений на формирование урожая горчицы сарептской на обыкновенном черноземе [Текст]: Радченко В.И. // Дис.канд. с.-х. наук: 06.01.09: - Саратов. - 1999. - 190 с.

ҚЫШАНЫҢ МИНЕРАЛДЫ ҚОРЕКТЕНУІН ОҢТАЙЛАНДЫРУ

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Түйін

Мақалада Қазақстанның астық өндірісін, атап айтқанда өсімдік шаруашылығын әртараптандыру бағдарламасында келешегі зор және құнды майлы дақылдардың бірі – қыша дақылына баға берілген. Қышаның минералды қоректену жағдайларын оңтайландыру бойынша жүргізілген зерттеу тәжірибелерінің қорытындылары сарапталған. Топырақтағы қоректік заттардың деңгейі мен қыша сорттарының өнімділігі арасындағы сандық байланысты анықтау үшін топырақта фосфор мен азоттың әртүрлі деңгейін құрудың 14 нұсқалы сұлбасы ұсынылған. Зерттеу жұмыстарының мақсаты (2019-2021 жж.) Солтүстік Қазақстанның далалық аймағында қыша дақылының минералды қоректену мен тыңайтқыштарға қажеттілігін анықтау. Олардың

негізгі бағыттары: берілген дақылдың құнарлылық деңгейіне және топырақ қасиеттеріне қойылатын талаптарын; топырақтың қасиеттерін зерттеу және олардың дақылдардың өнімділігіне әсерін зерттеу. Зерттеу жүргізілген жылдары қышаның өсіп-өнуі топырақтағы фосфордың жетіспеушілігі жағдайында, азоттың орташа, калий қорының жоғары мөлшері жағдайында дамыды. Азотты-фосфорлы тыңайтқыштарды қолдану топырақтағы нитратты азот пен жылжымалы фосфордың мөлшерінің 2-3 есе жоғарылауына ықпал етті және олардың топырақтағы мөлшері енгізілген тыңайтқыштардың мөлшеріне сәйкес өзгерді. Тыңайтқыш қолданылмаған аяда қыша дақылының өнімділігі төмен болды, өнім құрауға негізінен тыңайтқыштар мөлшері, топырақтың ылғалдылығы және топырақтағы қоректік заттардың мөлшері әсер етті. Бұл қышаның тыңайтқыштардың мөлшеріне және құрамындағы қоректік заттардың арақатынасына сәйкес өзгергенін көрсетті.

Кілт сөздер: қыша; оңтүстік қара топырақ; нитратты азот; жылжымалы фосфор; минералды тыңайтқыштар; өнімділік.

ОПТИМИЗАЦИЯ МИНЕРАЛЬНОГО ПИТАНИЯ ГОРЧИЦЫ

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Аннотация

В статье дается оценка одной из перспективных и ценных масличных культур – горчице, выращивание которой предусмотрена программой диверсификации зернового производства Казахстана, в частности, растениеводства. Выявлено, что условия минерального питания горчицы в степной зоне Северного Казахстана были не изучены. Поэтому были заложены опыты по изучению оптимизаций условий минерального питания горчицы. Представлена 14 вариантная схема для создания различных уровней содержания в почве фосфора и азота с целью определения количественной взаимосвязи между уровнем содержания элементов питания в почве и продуктивностью сортов горчицы. Целью исследований (2019-2021 гг) ставились изучить особенности минерального питания и удобрения горчицы в условиях степной зоны Северного Казахстана. Их основными направлениями были: изучить требования данной культуры к уровню плодородия и свойств почвы; изучить свойства почвы и определить ее возможности удовлетворять потребность культур. Выводы исследований говорят о том, что во все годы горчица развивалась в условиях дефицита фосфора в почве, средней обеспеченности азотом и только по калию - повышенной. Внесение азотно-фосфорных удобрений способствовало повышению содержания азота нитратов и подвижного фосфора в почве в 2-3 раза и определялось количеством внесенных удобрений. Продуктивность горчицы на естественном неудобренном фоне была низкой, она зависела от дозы удобрений, влажности почвы, исходного содержания элементов питания. Этим и объясняется неоднозначная реакция горчицы на внесение одних и тех же видов, доз и сочетаний удобрений.

Ключевые слова: горчица; чернозем южный; нитратный азот; подвижный фосфор; минеральные удобрения; урожайность.