UDC 633.854

G.A. Saparov [1,2], G.T. Isanova [1,2], A. Saparov [1,2], T.E. Aitbaev[3]

EFFECT OF MINERAL AND ORGANIC FERTILIZERS ON GROWTH, DEVELOPMENT, YIELD CAPACITY AND QUALITY OF CABBAGE

[1]Research Center for Ecology and Environment of Central Asia, 050060, Almaty, 75 B, al-Farabi avenue, Kazakhstan, e-mail: saparov.g@mail.ru

[2]U.U. Uspanov Kazakh Research Institute of Soil Science and Agrochemistry, 050060, Almaty, 75 B, al-Farabi avenue, Kazakhstan, e-mail: saparov.g@mail.ru

[3]Kazakh Research Institute of Potato and Vegetable Growing, 040917, Almaty Region, Karasai District, Kainar Village, ul. Nauryz 1, Kazakhstan, e-mail: niikoh.nauka@rambler.ru

Abstract. Fertilizers play an important role in regulating soil humus concentration and crop productivity. The optimal and rational application of fertilizer provides higher quality yield. In this study, the impact of mineral and organic fertilizers (manure) on the growth and development of cabbage has been explored. The use of mineral fertilizers on natural and organic backgrounds contributed to the increase in the average plant mass to 2,862 and 3,333 g. The yield capacity when using mineral fertilizers increased to 41.0 t/ha, the increase in yield to control was 9,3 t/ha or 29,3 %. The creation of an organic background increased the yield of cabbage by 3.5 t/ha in comparison with natural, and mineral fertilizers on the organic background by 10,2 t/ha. The use of fertilizers in agriculture is one of the key factors of conservation and optimization of soil fertility and crop productivity.

Key words: fertilizer, nutrition condition, cabbage, yield, quality.

INTRODUCTION

Irrigated foothill dark chestnut soils of the Trans-Ili Alatau are agri terrains of intensive farming. On these soils, agricultural crops are intensively cultivated, in particular white cabbage and potatoes. By gross harvest white cabbage takes first place among vegetable crops. The basis for increasing crop yields and improving the obtained product quality and increasing soil fertility is chemicalization of farming. To obtain high harvests of cabbage and improve the quality of cabbage, it is required to apply optimal doses of fertilizers. The greatest return on fertilizers is obtained when they are applied taking into account the plants' need for nutrients and provision of soil with mobile nutrients.

The most important condition for increasing the effectiveness of fertilizers is the determination of optimal doses and ratios of nutrients, taking into account the biological characteristics of cultivated crops, planned yields, soil-climatic, organizational and economic conditions and properties of the used fertilizers.

Currently, there is a trend of biologization of land cultivation, which assumes the use of organic fertilizers (manure, bird droppings, etc.), straw, siderates, humates combined with moderate doses of mineral fertilizers in order to preserve and optimize soil fertility.

The most important factor in preserving soil fertility is the use of fertilizers. Fertilizers play an important role in regulating humus concentration and crop productivity. Organic fertilizers, as a rule, determine the formation of humus reserves, the composition of new humus substances and soil energy potential, have a complex effect on all factors of soil fertility such as biological, agrophysical, agroecological and phytosanitary. Therefore, in intensive farming, the required optimization of specific parameters of humus state can be achieved by applying organic fertilizers into soil [1, 2].

Mineral fertilizers have a direct and indirect effect on humus concentration

and composition. Their direct impact is manifested in the changed conditions of humus formation: the reaction of the environment, peptization of humic substances, and the effect on soil biochemical activity. Indirect - in the increased biomass of plant residues entering the soil in fertilizers application, which contributes to the reduction of humus loss in comparison with not fertilized soil [3-5].

Due to the indirect effect, the effect of mineral fertilizers is much weaker than that of organic fertilizers. Nevertheless, the positive role of mineral fertilizer systems in preserving humus, reducing its losses, especially on humus-poor soils, is clearly manifested.

The data of G.P. Gamzikov and M.N. Kulagin [6] determined that the use of industrial fertilizers reduces the loss of organic matter and nitrogen in soils, in many cases stabilizing their quantity at the initial level.

Prolonged use of fertilizers increases the concentration of easy hydrolyzable and nitrogen-accessible nitrogen compounds, enriches them with water-soluble, hydrophilic organic substances, mobile humus fractions, increases humus activity.

Under the impact of mineral fertilizers, especially nitrogen fertilizers, the coefficient of humification of plant residues increases [7, 8]. It has been determined that nitrogen of mineral fertilizers is included in all fractions of soil organic matter [9, 10].

The aim of these studies is to explore the effect of mineral fertilizers on the yield and quality of cabbage.

OBJECTS AND METHODS

The object of the study is the dark chestnut soil of the foothills of the Trans-Ili Alatau in conditions of irrigation and cultivation of vegetable crops, in particular, the Kharkov winter cabbage variety.

The climate of the foothill belt of Ile Alatau is characterized by large daily and annual variations in air temperature, cold winters, prolonged hot summers. The average temperature in January is -6-14^{0}C frost and 22-25^{0}C in July.

The average long-term annual precipitation for the period above 10^{0}C is 175-250 mm, and the sum of air humidity deficits for this period is 1500-1700 mm.

On average, the soil freezes to the depth of 15-55 cm. The average duration of the frost-free period is 140-170 days [11, 12].

Heat supply of vegetation period of the foothill belt allows to grow many heat-loving crops, including vegetables.

The research was carried out in two vegetable crop rotations:

1. In intensive vegetable rotation - on two backgrounds (natural and organic - 60 tons/ha) with alternation of crops: cereals, late cabbage, cucumber, tomato and table root crops. Experimental studies were conducted on the late cabbage - Kharkov winter variety, where fertilizer variants were studied according to the following scheme:

$N_0 P_0 K_0$ (control)

$N_{60} P_{30} K_{30}$

$N_{120} P_{60} K_{60}$

$N_{180} P_{90} K_{90}$

Soil research was carried out on two fertilizer variants:

1. $N_0 P_0 K_0$- control (without fertilizers).

2. $N_{120} P_{60} K_{60}$ - a moderate dose of mineral fertilizers.

In the experiments, urea (46 % a.s.), double superphosphate (46 % a.s.) and potassium chloride (60 % a.s.) and half-repulsed manure (60 t /ha) were used. The area of the experiment is 0,5 ha, the plot area is 224 m^2.

Manure and phosphate-potassium fertilizers were applied in autumn in plowland, and nitric fertilizers - in the spring in deep cultivation.

2. Vegetables - grass-crop rotation with alternating crops - cereals with sowing perennial grasses, perennial grasses, potatoes, cabbage, cucumber, tomato, table

root crops. Experimental studies were carried out on fertilizer variants according to the following scheme:

$N_0 P_0 K_0$

$N_{60} P_{60} K_{60}$

$N_{120} P_{120} K_{120}$

$N_{180} P_{180} K_{180}$

Soil research was carried out on the following options:

1. $N_0 P_0 K_0$ (control).

2. $N_{120} P_{120} K_{120}$ - optimal dose of mineral fertilizers.

The experiment area is 0,5 ha, the plot area is 42 m^2.

RESULTS AND DISCUSSION

Growth and development of cabbage plants. In this research, the application of manure and mineral fertilizers to optimize the parameters of soil fertility has provided favorable conditions for the nutrition of vegetable crops. High supply of plants with easily digestible forms of nutrients promoted their intensive growth and development, the formation of a larger biomass and, ultimately, production of high yields of vegetables, in particular cabbage.

The results of our studies have shown that the intensity of accumulation of biomass of vegetable plants depends on the conditions of their mineral nutrition.

At the beginning of vegetation, the weight of cabbage in the non-fertilized variant (control) was 11,6 grams, and on the background of mineral fertilizer, it increased to 17,7 g, which indicates the growth and development of cabbage under the influence of mineral fertilizers (figure1).

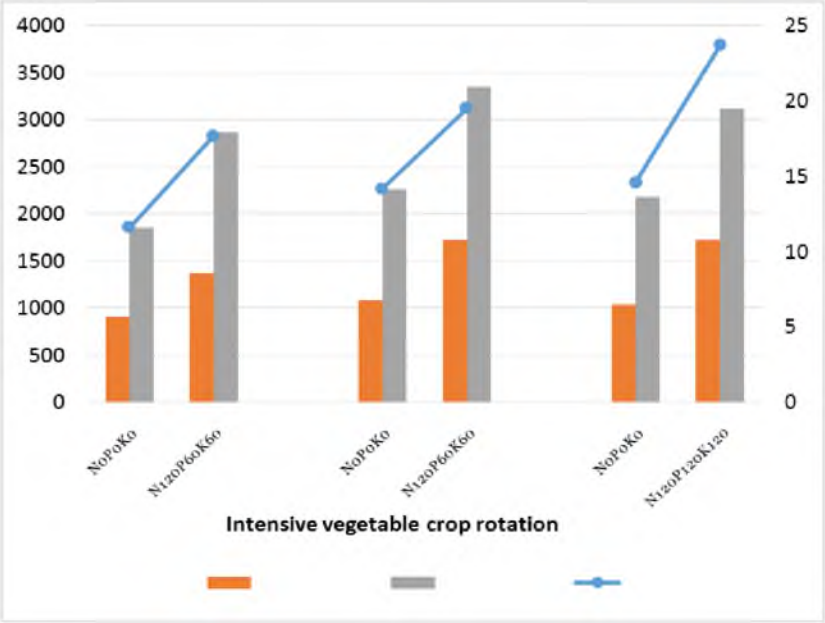

Figure 1- Growth and development of cabbage depending on nutrition condition (weight, g: 1 plant)

The creation of an organic background by applying 60 t/ha manure contributed to the improvement of growth and development of cabbage plants. So, the average weight of cabbage in the control (without mineral fertilizers) increased by 2,6 g compared with natural background, and in the options of mineral fertilizer - by 1,8 g.

Intensive growth and development of cabbage plants is observed in the first half of vegetation. The weight of 1 plant from the phase of 3-5 real leaves to the phase of head formation increased in aver-

age 90-100 times and amounted to 910g on natural background, and 1806 g on the organic background, in applying mineral fertilizers, the plant weight increased to 1373 and 1718 g, respectively (figure 1).

The largest biomass of cabbage was formed by the period of technical ripeness. On the background without mineral fertilizers, the average weight of cabbage on a natural background was 1853 g, and on the organic one - 2262 g. The application of mineral fertilizers on different backgrounds increased the average weight of plants to 2,862 and 3,333 g (figure 2)

The same situation was observed on the background of vegetable-grass crop rotation, where mineral fertilizers also contribute to the increase in the mass of cabbage plants.

In our studies, the late cabbage heads formation was relativelylow and made up 60,0% on a control variant of the intensive vegetable crop rotation on natural background, and on fertilized variants 63,5% (figure 2).

On an organic background, these figures were 62,5 and 66,0% (figure 2).

The number of plants that formed cabbage heads on different backgrounds was 13,2 and 13,75 thous. pieces/ha, 13,97 and 14,52 thous. pieces/ha on fertilized.

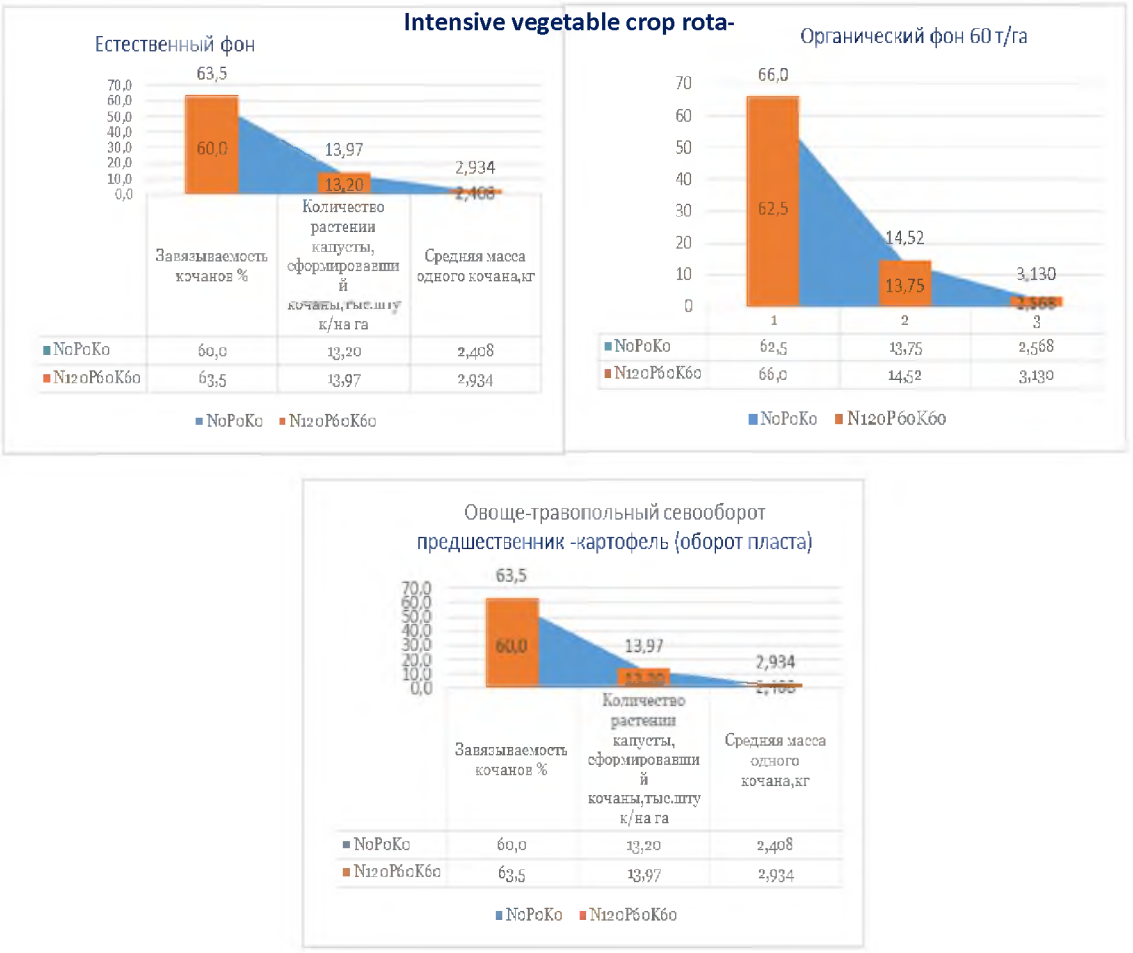

Figure 2- Formation of cabbage heads depending on mineral nutrition

The average weight of cabbage head on different backgrounds without the use of mineral fertilizers amounted to 2,408-2,568 g, and the use of mineral fertilizers contributed to the increase in the average weight of plants to 2,934-3,130 g (figure 2).

The average weight of cabbage plants on the background of vegetable-grass crop rotation was slightly less than in intensive vegetable rotation.

The conditions of growing, in particular, mineral nutrition, contribute to the intensive growth and development of late cabbage.

Yield capacity and quality of cabbage. The results of our studies showed that the yield of vegetable crops and cabbage is largely determined by the conditions of their mineral nutrition and soil fertility.

The yield of white cabbage, depending on the type of crop rotation (predecessor), the system of fertilizer application varies widely.

In intensive vegetable rotation without the use of organic-mineral fertilizers, the yield of late cabbage heads (Kharkov Winter), planted after barley, was 31,7 tons/ha. The use of a full mineral fertilizer contributed to the increased crop yield to 41,0 t/ha (figure 3), while the yield increase to the control was 9,3 t/ha or 29,3 %.

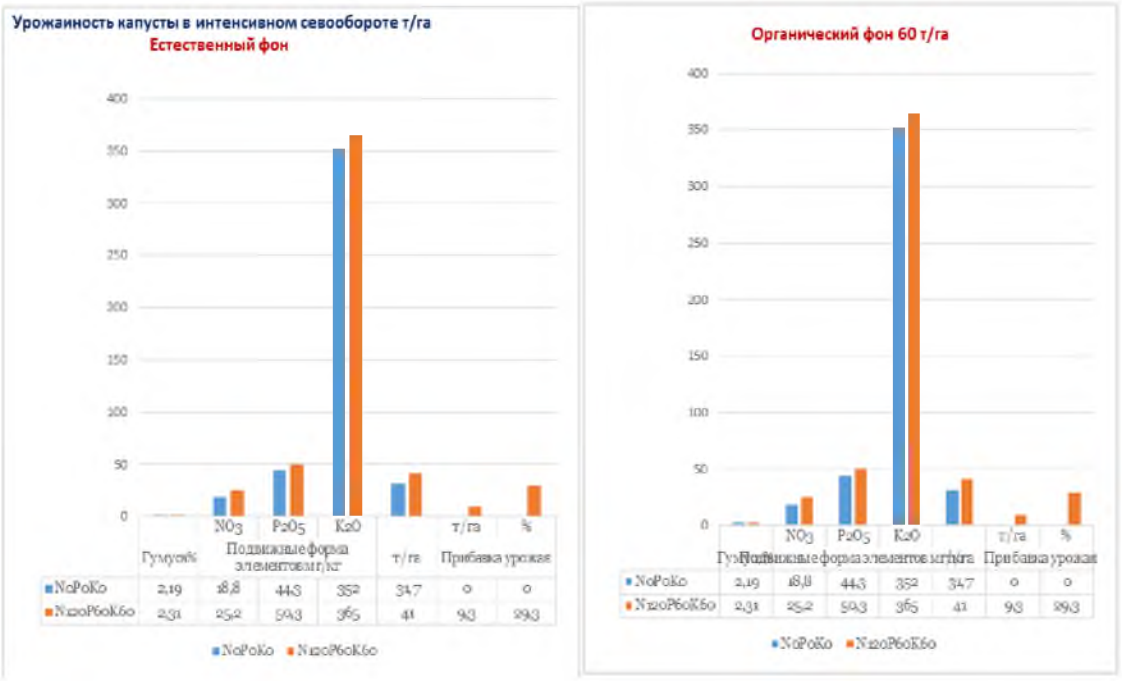

Figure 3 - Cabbage yield in intensive crop rotation t / ha

Creation of organic background (60 t/ha manure) increased the yield of cabbage by 3,5 t/ha in comparison with natural, and mineral fertilizers on organic background - by 10.2 t/ha.

The use of mineral fertilizers in crops of cabbage contributed to the increased yield of cabbage, both on a natural background and on organic (figure 3). A similar change in the yield of cabbage was also observed in the conditions of vegetable-grass crop rotation, where it was grown in terms of the turnover of the perennial leguminous grass. Without application of fertilizers 31,0 t/ha of cabbage heads were harvested. The introduction of a full mineral fertilizer contributed to the increased yield of cabbage to 37,3 t/ha and the increased yields to 20,3 % (table 1).

Table 1 –Yield capacity of crops of vegetable-grass crop rotation, t/ha

Variants	Yield capacity of cabbage and potato		
	t/ha	Yield gain	
		t/ha	%
Potato			
$N_0P_0K_0$	17,2	-	-
$N_{120}P_{120}K_{120}$	22,8	5,6	31,6
Late Cabbage			
$N_0P_0K_0$	31,0	-	-
$N_{120}P_{120}K_{120}$	37,3	6,3	20,3

White cabbage, when forming a powerful biomass, can form high harvests of cabbage heads. Among vegetable crops, it is characterized by a long period of absorption of nutrients and a high level of their removal. Therefore, cabbage is very responsive to the application of both organic and mineral fertilizers. In our studies, the use of fertilizers contributed to the significant increase in the yield of cabbage.

Along with productivity of agricultural crops, their quality indicators are also of great importance. This is especially important in growing vegetables, as many of them are eaten fresh. Vegetables are a "storehouse" of vitamins and valuable raw materials for the processing industry.

Every day the adult person needs about 400 g of vegetables and melons to meet the need for carbohydrates, vegetable proteins, salts, acids, vitamins and other vital substances. Annual per capita should be 126 kg of vegetables, 20 kg of melons and 100 kg of potatoes, including 35 kg of white cabbage [13].

The quality and shelf life of vegetable products are closely interrelated with the conditions of cultivation, in particular, mineral nutrition. Therefore, in our studies we also studied these issues.

The results of the research showed that the conditions of mineral nutrition have a significant effect on the quality and keeping quality of cabbage and vegetables. The dry matter content in the cabbage heads was 9,46 % on the background without fertilizer application, and in application of mineral fertilizers a slight tendency to decrease the dry matter was observed (9,20 %) (table 2).

Table 2 - Effect of mineral nutrition on the quality of cabbage

Fertilizer rates, kg/ha a.s.	Dry matter	Vitamin C, mg%	Total sugar, %	Nitrates, mg/kg
Intense vegetable crop rotation, Natural background				
$N_0P_0K_0$	9,46	32,72	4,60	236
$N_{120}P_{60}K_{60}$	9,20	37,11	4,60	323
Organic background 60 t / ha				
$N_0P_0K_0$	8,81	37,21	4,55	291
$N_{120}P_{60}K_{60}$	9,12	40,38	4,60	420
Vegetable-grass crop rotation				
$N_0P_0K_0$	11,00	33,24	5,00	261
$N_{120}P_{120}K_{120}$	11,06	37,44	5,31	465

On an organic background without the use of mineral fertilizers, 8,81 % dry matter was contained in the cabbage, and on the fertilized variant - 9,12 %. Of the quality indicators of cabbage, the most valuable is the content of vitamin C. It was relatively high (32-40 mg %) and markedly increased under the influence of fertilizers.

The total sugar content in the cabbage was more leveled on the background of intensive vegetable crop rotation (4,60 %) and slightly increased on the background of vegetable-grass crop rotation (5,0-5,31%). The increased content of nitrates in production was noted in variants with fertilizer applications (323-465 mg/kg), at the maximum permissible concentration (MPC) of -500 mg/

kg wet weight (table 3).

The high concentration of nitrates in cabbages is also noted in conditions of vegetable-grass crop rotation, which is associated with a large amount of nitrogen in soil after alfalfa.

Table 3 - Effect of fertilizers on the shelf life of white cabbage

Variants	Shelf life, %	Total losses, %	Including		
			Natural los of weight	Partially diseased cabbage heads	Completely decayed
Cabbage heads grown on natural background					
$N_0P_0K_0$	74,8	25,2	9,7	7,1	8,4
$N_{120}P_{60}K_{60}$	75,2	24,8	9,7	8,7	6,4
Cabbage heads grown on organic background (60 t/ha manure)					
$N_0P_0K_0$	74,0	26,0	9,5	8,2	8,3
$N_{120}P_{60}K_{60}$	73,6	26,4	10,1	7,9	8,4

The results of the research have shown that conditions of mineral nutrition have a significant effect on preservation of the products for a long-term storage.

After storage (November-March), total loss of cabbage without the use of fertilizers amounted to 25,2 % (Table 3).

Preservation of cabbage heads, grown with the use of mineral fertilizers, was at the level of control. The use of mineral fertilizers on the background of 60 t/ha of manure affected the preservation capacity of cabbage (73.6 %) in 74,0-74,8 of control variant.

CONCLUSION

In order to preserve and enhance bioproductivity of dark chestnut soils in vegetable crop rotations, it is necessary to create a background for late cabbage by applying 60 t/ha of manure and mineral fertilizers in optimal doses ($N_{120}P_{60}K_{60}$).

Intensive-vegetable crop rotation against the background of organic and organic-mineral fertilizers increases humus concentration and elements of fertility of dark chestnut soils. From manure (60 t/ha), humus concentration increased by 4,1 %, from mineral fertilizers by 5,5 %, and by combination of organic-mineral fertilizers by 9,6 %.

The use of fertilizers in late cabbage in intensive crop rotation increases its yield on the natural background to 9,3 t/ha, on organic background - up to 10,2 t/ha, in vegetable-grass crop rotation - up to 6,3 t/ha.

REFERENCES

1 Savich V.I., Diallo S.B. Agronomical assessment of soil organic matter, Izv. TAA. - 1989. - Issue. 3. - P.61-68.

2 Savich V.I. Theoretical foundations for the selection of the optimum parameters of soil fertility, Izv. TAA-1990. - Issue. 6. - P. 47-56.

3 Krupkin P.I. Results and Prospects of Research on Optimizing Doses of Fertilizers in Central Siberia // Agrochemistry. - 1991.-№2. - P. 35-45.

4 Shevtsova L.K., Drobkov Yu.A. Humus concentration in the soils of the Non-Black Earth Region with prolonged fertilization // Pochvovedenie. - 1981.- №10. - P.113-120.

5 Friedland E.V. Influence of cultivation on soil organic matter // Agrochemistry - 1985.- №3. - P.112-123.

6 Gamzikov G.P., Kulagina M.N. Change in soil humus concentration as a result of agricultural use // Survey information VNIITEIagroprom. - M., 1992. - 48 p.

7 Mineev V.G., Rempe E.Kh. Ecological consequences of prolonged use of elevated and high doses of mineral fertilizers // Agrochemistry. - 1991. - № 3. - p. 35-49.

8 Pannikov V.D. Theory and practice of increasing soil fertility// Vestnik selhoz nauki. - 1981. - №2. - P. 14-23.

9 Dyakonova K.V., Buleeva V.S. Balance and transformation of organic matter of sod -podzolic soils in the center of the Non-black soil area//Organic matter of arable soils / Dokuchaev Soil Science Institute. - M., 1987. - P. 12-22.

10 Gamzikov, G.P. Nitrogen in agriculture of Western Siberia. - Moscow: Nauka, 1981. - 267 p.

11 Agroclimatic resources of Alma-Ata region Kaz SSR. - L., 1978. - 200 p.

12 Recommendations on agricultural system of Almaty region. - Alma-Ata: "Kainar", 1978. - 342 p.

13 Directory of vegetable grower Alma-Ata. - 1978. - 286 p.

ТҮЙІН

Г.А. Сапаров [1,2], Г.Т. Исанова [1,2], А.Сапаров [1,2], Т.Е.Айтбаев [3]

ОРАМЖАПЫРАҚТЫҢ ӨСУІ, ДАМУЫ, ӨНІМДІЛІГІ МЕН САПАСЫНА МИНЕРАЛДЫ ЖӘНЕ ОРГАНИКАЛЫҚ ТЫҢАЙТҚЫШТАРДЫҢ ӘСЕРІ

[1]Орталық Азия экология және қоршаған орта ғылыми-зерттеу орталығы, 050060, Алматы, әл-Фараби даңғылы, 75 В, Қазақстан, e-mail: saparov.g@mail.ru

[2]Ө.О. Оспанов атындағы Қазақ топырақтану және агрохимия ғылыми-зерттеу институты, 050060, Алматы, әл-Фараби даңғылы, 75 В, Қазақстан, e-mail: saparov.g@mail.ru

[3]Қазақ Картоп және көкөніс ғылыми-зерттеу институты, 040917, Алматы обл, Қарасай ауданы, Наурыз 1, Қазақстан e-mail: niikoh.nauka@rambler.ru

Тыңайтқыштар топырақтағы қарашірінді құрамын және дақылдардың өнімділігін реттеуде үлкен рольге ие. Тыңайтқыштарды тиімді және ұтымды қолдану өнімділіктің жоғарғы сапасын қамтамасыз етеді. Аталған зерттеу жұмысында минералды тыңайтқыштардың және көңнің орамжапырақ пен картоптың дамуына және өсуіне әсері зерттелді. Әр түрлі фонда минеральды тыңайтқыштарды қолдану өсімдіктің орташа массасын 2862 және 3353 г дейін өсіруге жағдай жасады. Дақылдың өнімділігі минеральды тыңайтқыштарды қолдану арқылы 41,0 т/га дейін жетті, қосымша өнім 9,3 т/га немесе 29,3 % құрады. Органикалық фон құру арқылы орамжапырақтың өнімділігін табиғи фонмен салыстырғанда 3,5 т/га, ал органикалық фондағы минеральды тыңайтқыштармен 10,2 т/га көтерілді. Ауыл шаруашылығында тыңайтқыштарды қолдану дақылдардың

өнімділігін және топыраққұнарлылығын сақтау мен оңтайландырудың негізгі факторларының бірі болып табылады.

Түйінді сөздер: тыңайтқыш,қоректену жағдайлары, орамжапырақ, өнім, сапа.

РЕЗЮМЕ

Г.А. Сапаров [1, 2], Г.Т. Исанова [1, 2], А. Сапаров [1, 2,] Т.Е. Айтбаев [3]

ВЛИЯНИЕ МИНЕРАЛЬНЫХ И ОРГАНИЧЕСКИХ УДОБРЕНИЙ НА РОСТ, РАЗВИТИЕ, УРОЖАЙНОСТЬ И КАЧЕСТВО КАПУСТЫ

[1]Научно-исследовательский центр экологии и окружающей среды Центральной Азии, 050060, Алматы, пр. аль-Фараби 75 В, Казахстан, e-mail: saparov.g@mail.ru

[2]Казахский научно-исследовательский институт почвоведения и агрохимии им. У.У. Успанова, 050060, Алматы, пр. аль-Фараби 75 в, Казахстан, e-mail: ab.saparov@mail.ru

[3]Казахский научно-исследовательский институт картофелеводства и овощеводства, 040917, Алматинская область, Карасайский район, п. Кайнар, ул. Наурыз 1, Казахстан, e-mail: niikoh.nauka@rambler.ru

Удобрения играют большую роль в регулировании содержания состава гумуса почвы и продуктивности культур. Оптимальное и рациональное применение удобрений обеспечивает более высокое качество урожая. В данном исследовании изучено влияние минеральных и органических удобрений (навоза) на рост и развитие капусты. Применение минеральных удобрений на естественном и органическом фонах способствовало увеличению средней массы растений до 2862 и 3353 г. Урожайность культуры при минеральном удобрений увеличилась до 41,0 т/га, прибавка урожая к контролю составила 9,3 т/га или 29,3 %. Создание органического фона повысило урожайность капусты на 3,5 т/га по сравнению с естественным, минеральные удобрения на органическом фоне на 10,2 т/га. Использование удобрений в сельском хозяйстве является одним из ключевых факторов сохранения и оптимизации почвенного плодородия и продуктивности культур.

Ключевые слова: удобрение, условие питания, капуста, урожай, качество.