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GROWTH PROCESSES OF SPRING CABBAGE CROPS INFLUENCE OF FERTILISER

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Abstract

In fodder production, cabbage plants have been grown for a long time, in particular fodder cabbage - a stalk-bearing plant and root crops - turnips and turnips. The group of cabbage stalks in fodder production has not become widespread, the range of species and varieties is also limited. Thus, in Ukraine and Moldova in the 70's on small areas were grown mainly fodder cabbage and rape, in the 80's the area of cabbage was expanded everywhere, the species composition of them expanded. Eper, in addition to winter rape and fodder cabbage, grow spring rape, winter rape, oil radish, perko, white mustard. Of particular importance is the relatively new forage crop typhoon (a hybrid of Chinese cabbage with turnips). However, it has not yet become widespread, although it is widely used in Europe and the United States. Less than other cabbage, perca culture is also common.

Cabbages are high protein plants. They can be grown in single crops and in mixtures with annual grasses and other crops. Against their background, it is better to feed by-products - straw chaff, chaff, etc. Green cabbage mass increases milk yield, milk fat content, growth of young animals for fattening. When feeding it to sheep, wool productivity increases. Cabbage - a valuable component of the diet of pigs and poultry. They are widely used in winter intermediate, early spring, post-harvest and post-harvest crops.

Cabbages are grown not only for green mass, but also for silage mixed with other crops. Their grain is a very valuable source of concentrated protein feed of the highest quality. Cake and meal from rapeseed, radish, oilseed rape are physiologically almost inferior to cake and meal from soybeans and sunflowers. Thus, the main protein component of concentrated feed in Western Europe (Belgium, Germany and especially in the Scandinavian countries) is cheap and high-quality rapeseed meal. Rapeseed yield reaches 30 c / ha, ie significantly higher than the average soybean yield and allows to have high-quality feed with minimal losses, which helps reduce the cost of livestock products[1,4,18].

Keywords: cabbage crops, spring rape, white mustard, oil radish, mineral fertilizer.

A rational fertilization system ensures that crops are optimally supplied with nitrogen, phosphorus and potassium compounds during the growing season. An organo-mineral fertilization system is effective in crop rotations. Doses of mineral fertilizers on the background of manure regulate the level of soil provision of mobile forms of nutrients, the amount of their removal by crops, which can reduce the cost of fertilizers per unit yield and their unproductive use.

Cabbage plants are grown not only for green mass, but also for silage mixed with other crops. Their grain is a very valuable source of high-quality concentrated protein fodder.

Intensive farming without mineral fertilizers is now as much an expression as hot ice or icy flames. Every agrarian knows: as much as you "throw" into the ground, you get out of it, so fertiliser is an important component of modern crop production. But do we all do the right thing and or do we apply exactly the right approaches to mineral nutrition? Even experienced agronomists often have to learn from experience that there are some blind spots in the knowledge and understanding of good mineral nutrition [1].

The productivity of cabbage crops primarily depends on soil and climatic conditions of growing, biological features of the crop, growing technology, fertilization, etc. [2,3]. The best predecessors for such crops are considered to be clean and fallow, also cereals, row crops and leguminous crops. It is not recommended to sow after beet, millet and sunflower, as well as annual grasses [5, 4].

White mustard (Sinapis alba L.) is a more cold-resistant and less drought-resistant crop. It grows well in areas with 450 mm or more of average annual rainfall. White mustard is characterized by a furrowed, branched stem that is covered with stiff, bristly hairs. The lower leaves are lyre-shaped, dissected, petiolate; the upper leaves are shortly petiolate, longitudinally linear, covered with stiff hairs. Flowers yellow with strong honey odor, collected in clusters of 25-100 flowers. Valuable oil-bearing crop. It is used for food, confectionery, technical and medicinal purposes. Mustard oil has the lowest acidity index and retains its quality characteristics longer [6]. In addition, white mustard is a good melliferous crop and an excellent precursor, and its roots are excellent at absorbing and assimilating low-soluble compounds of phosphorus and potassium, while creating a good soil microflora. Mustard is distinguished by its volatile and cold tolerance, and it is also less demanding to the soil conditions of cultivation, so in Ukraine there is a tendency to expand the area of cultivation of this crop [7-10].

Oil radish (Raphanus sativum d. Var. Oleifera Metrg.) is a cold-resistant crop. Seeds begin to germinate at 2°C; the optimum temperature for germination is 10-12°C. Seeds can survive frosts as low as minus 3-4°C, and mature plants can grow to minus 5-6°C. Oil radish is considered a relatively new and promising crop in modern horticulture and is grown as a valuable technical, oil-bearing, fodder and hybrid crop. Oil radish is mainly used as a fodder crop and is relatively undemanding in its growing conditions, early maturing, resistant to disease damage, quickly able to form a massive crop of biomass. The application of mineral fertilizers for all the above-mentioned cabbage crops is one of the important elements of cultivation technology, which helps to ensure optimal nutritional conditions for

the crop and, as a consequence, ensures its high productivity [10,11,12].

Spring rape (Brassica napus oleifera annua Metzg.) is a typical cold-resistant plant that, when sown in spring, goes through all phases of growth and development and forms seeds. The growing season of spring rape is 95-110 days. Sprouts appear on the 5th-6th day after sowing in the form of asymmetrical blue-green sycamores. The first true leaves of the rosette are rounded in shape, mostly undescended [17].

Under the new conditions of farming, there is a need both to improve the traditional fertilizer systems, and to develop new ones that can quickly take into account changes in the market situation (prices and demand for agricultural products and chemicals).

However, under the conditions of acute shortage of mineral fertilizers and a sharp decrease in the use of organic fertilizers, a stable yield is conditioned by the preservation and further improvement of soil fertility as a result of the optimization of mineral nutrition of crops in the field crop rotation [13].

Oilseed crops need more fertilizers than cereals. The assimilation of nutritional elements by plants of winter rape, kg per 1 t of the main and by-products, is: nitrogen - 47-65, phosphorus - 22-40, potassium - 50-80, calcium - 30-70, magnesium - 7-12, sulphur - 15-30. Mustard extracts 72 kg of nitrogen, 28 kg of phosphorus and 54 kg of potassium from soil per 1 t of main and by-products [14].

Studies by A.P. Alekseev and K.M. Melentieva [15] found that nitrogen is intensively consumed by mustard plants throughout the growing season. The greatest amount of nitrogen is concentrated in the letter. Excess nitrogen at a young age leads to its accumulation in the form of intermediate products of nitrogen metabolism, harmful to the plant. An acute nitrogen deficiency, if excluded from the fertilizer complex, leads to insufficient leaf development of the plants.

In general, cabbage oilseeds respond to the nitrogen fertilizer supply in the soil. An important factor determining the effectiveness of nitrogen fertilizers is the natural supply of phosphate available to plants in the soil. The higher it is, the better the crops consume nitrogen fertilizers. Consequently, the efficiency of nitrogen fertilizers is determined by a complex set of natural factors, the most important of which are climatic features of the territory and specifics of soil cover. Therefore, when solving practical issues, it is necessary to take into account the factors affecting nitrogen accumulation in soil: temperature and water regimes, the stock of organic matter in the soil, the presence of signs of solonetzicity, as well as contributing to the realization of accumulated nitrogen: moisture, provision of soil with other nutrition elements [16].

The application of mineral fertilizers is an obligatory point in the algorithm of actions of a modern agronomist. But due to carelessness or imperfect composition, this seemingly useful process can harm both crops and the environment as a whole. Worst of all, unlike the atmosphere and hydrosphere, where there are processes of periodic self-purification from heavy metals, soil has virtually no such self-purification ability.

The metals that accumulate in the soil are removed from it extremely slowly and only through leaching, consumption by plants, erosion and deflation. Therefore, it is necessary to follow the technology of fertilizer application, to monitor their composition and quality [1].

Thus, the analysis of the scientific literature shows that among the researchers there is no consensus on the doses of mineral fertilizers for oilseed rape crops, in particular the ratio of the use of nitrogen fertilizers in the main fertilizer and top dressing, the use of forms of nitrogen fertilizers, etc. Therefore, this issue requires detailed study on the application of fertilizer system in the technologies of growing spring rape, white mustard and oil radish.

The area of the site, within which the research was conducted, belongs to the central part of the forest-steppe of Ukraine. Land resources and favorable climatic conditions of this zone cause high potential of agricultural production.

The soil cover of Vinnitsa region is represented by 36 kinds of soils with different physical and chemical properties. Black earths occupy about half of the areas in the region. Typical black earths (28.4%), meadows (1.8%) and podzols (19.9%), dark grey podzols occupy 17.9% of the area. Almost one third of the farmland area is occupied by light grey and grey forest soils.

On the territory of the farm the grey forest podzoled soils prevail, formed under broad-leaved forests in the conditions of moderately humid and warm climate, mainly on loess rocks.

They have all the features of poorly saturated bases and little structured soils. Due to low texture and unfavourable water-air properties clumps are formed during ploughing. They settle quickly after tillage and are easily swamped.

The depth of humus eluvial horizon is 25-30 cm. Below this there is a compacted eluvium horizon and a soil-forming rock or forest. Depth of carbonate occurrence is 80-170 cm. According to granulometric composition these soils are loamy.

Agrochemical indices of the arable layer are as follows: humus content 1,9%, pH - 5,2, hydrolytic acidity - 36,7 mg.-equivalent per 1 kg of soil, sum of absorbed bases - 176 mg. Eq. per 1 kg of soil, alkalinity - 93,7%, easily hydrolyzed nitrogen with Cornfield - 62,0 mg, mobile phosphorus and available potassium according to Chirikov - 105 and 119 mg per 1 kg of soil respectively.

The meteorological conditions prevailing during the study period with cabbage crops were favourable for the formation of high fodder productivity.

The precursor for cabbage crops was winter wheat for grain. After threshing of wheat stubble ploughing was carried out to the depth of 5-7 cm and after weeds germination - autumn ploughing to a depth of 25-27 cm.

Pre-sowing preparation involved the application of mineral fertilizers followed by cultivation to a depth of 12-15 cm. The soil was levelled and compacted by the RVC-5,6 combined aggregate.

Sowing was carried out by SZT-3,6 seeder. Seeds of cabbage crops were sown by conventional line

method (15 cm) to the depth of 1,5-2,0 cm. Consumption rate of the seed material was spring rapeseed variety of sturgeon - 2.0, white mustard varieties Carolina - 3.0, oil radish Zhuravka - 2 , 5 million pcs. germinated seeds per hectare. After sowing, rolling with 3KSh-6 ring-spiked rollers was carried out.

Collection of leaf mass of cabbage crops for green fodder was carried out at the beginning of the flowering phase.

The field studies were accompanied by the following common observations, counts and laboratory analyses:

- Phenological observations were carried out according to the "Methodology for State Variety Testing". At the same time, the beginning of the phase was noted when it occurred in 10% of plants and full phase in 75% of plants;

- plant height and leaf mass yield were determined by conventional methods;

- forage productivity of cabbage crops;

- mathematical processing of the obtained results was carried out by means of dispersion analysis on a computer using modern software packages.

In studies, the object of which is a plant, necessarily plan phenological observations, the essence of which is to record the dates of the phases of growth and development of plants. This makes it possible to carry out in a timely manner all agronomic techniques provided by the cultivation technology, as well as monitor changes in growth and development of plants, associated with the influence of the factors put to the study. Along with such measures, determine the duration of interphase periods and the total duration of the growing season, which primarily depend on the genetic characteristics of the variety and environmental factors.

According to the results of our studies, we found that the period "sowing - full sprouting" in spring rape lasted 10 days, in white mustard - 9 days and in oil radish - 6 days, regardless of the levels of mineral nutrition (Table 1).

Table 1

Effect of mineral nutrient levels on the duration of interphase periods of development of spring cabbage crops (average for 2018-2019)

Levels of mineral nutrition	Crop	sowing - sprouting	ladders - 1 true leaf	1 true leaf - rosette	rosette of leaves - stemming	stemming - budding	budding - beginning of flowering	sowing - beginning of flowering
Without fertilizer (control)	Spring rape	10	9	17	11	12	10	69
	White mustard	9	7	10	9	10	7	52
	Oil radish	6	6	14	13	12	11	62
$N_{30}P_{30}K_{30}$	Spring rape	10	9	18	12	13	11	73
	Whit mustard	9	8	10	10	11	8	56
	Oil radish	6	7	15	14	13	13	68
$N_{60}P_{60}K_{60}$	Spring rape	10	10	19	12	14	12	77
	White mustard	9	8	11	10	12	9	59
	Oil radish	6	7	15	14	14	13	69

Subsequently, the period "sprouting - first true leaf" for spring rape lasted 9-10 days, for white mustard - 7-8 days, for oil radish - 6-7 days.

Such an interphase period as "the first true leaf - the rosette of leaves" lasted 17-19 days for spring rape, 10-11 days - for white mustard, and 14-15 days - for oil radish.

It was marked that depending on the level of mineral nutrition the duration of the phase period "rosette of leaves - stemming" for spring rape was 11-12 days, for white mustard - 9-10 days, for oil radish - 13-14 days.

The period "stemming - budding" was 12-14 days for spring rape, 10-12 days for white mustard and 12-14 days for oil radish.

The interphase period between budding and flowering for spring rape was found to be 10-12 days. This period was somewhat less for white mustard - 7-9 days, and more for oil radish - 11-13 days.

So, improvement of mineral nutrition conditions for spring cabbage plants by introducing N60P60K60 into pre-sowing cultivation had promoted to prolongation of interphase periods on the whole and the period from shoots till mowing in particular.

It has been noted that under these conditions the flowering period in spring rape was reached in 77 days after sowing, in white mustard - in 59 days, in oil radish - in 69 days.

Yield of various crops is determined by many parameters, important of which are biometric parameters of plants - height, density of herbage, leaf surface area and others. Therefore, in the experiment we studied how the height of spring cabbage crops varies depending on the conditions of mineral nutrition. The height of the plants was measured with a ruler. The height of the stem is measured from the soil surface to the top of the plant. The average height of the plants is the summing indicator.

It was found that the height of the cabbage plants differed depending on the crop as well as on the dose of mineral fertilizers applied during the lean period (the beginning of the flowering phase).

At the variant without fertilization the height of spring rape plants was 75.7 cm, and with the application of mineral fertilizers at a dose of $N_{30}P_{30}K_{30}$, it increased by 17.0 cm and was 92.7 cm (Table 2).

Table 2

Shaping the height of cabbage crops at plant emergence, cm (average for 2018-2019)

Crops	Level of mineral nutrition		
	Without fertilizer (control)	$N_{30}P_{30}K_{30}$	$N_{60}P_{60}K_{60}$
Spring rape	75,7	92,7	112,4
White mustard	73,1	90,4	107,2
Oil radish	66,4	87,3	96,5

Increasing the dose of mineral fertilizer to $N_{60}P_{60}K_{60}$ contributed to the formation of the highest height indicators, namely 112.4 cm. Compared to the control, the height of spring rape plants increased by 36.7 cm.

Cultivation of white mustard on the control version provided the plant height of 73.1 cm, while the application of basic micro fertilizer in 30 and 60 kg of the active substance stimulated intensive growth of plants in height. Thus, in the first case the height of white mustard was 90.4 cm and in the second - 107.2 cm. Thus, the height of white mustard plants on the fertilized variants increased by 17.3 and 34.1 cm compared to the control.

Among spring cabbage crops, oil radish was distinguished by the lowest plant height. So, on the variant without fertilizers the height of plants was 66,4 cm. At the dose of $N_{30}P_{30}K_{30}$ mineral fertilizers 87.3 cm, at application of $N_{60}P_{60}K_{60}$ - 96.5 cm, i.e., plant height increased by 20.9 and 30.1 cm compared to the control.

Thus, the height of spring cabbage plants significantly depended on the mineral fertilizers. The highest height was observed when $N_{60}P_{60}K_{60}$ was used for pre-sowing tillage. At the same time an increase of 36,7 cm was noted in spring rape, 34,1 cm in white mustard and 30,1 cm in oil radish, compared to the control.

The yield of each crop is a complex integral value, which depends on many, both internal and external factors. Light, heat, air oxygen and carbon dioxide, as well as the water and nutrient regimes of the soil, have the greatest influence on the productivity of the herbage. In our experiments we studied how the yield of spring cabbage crops changes depending on the applied doses of mineral fertilizers.

Our field researches have shown, that the crop capacity of spring rape at the variant without fertilizers was 20.1 t/ha, at application of fertilizers in a dozen $N_{30}P_{30}K_{30}$ it was 27.5 t/ha, whereas at application of $N_{60}P_{60}K_{60}$ it was 34.1 t/ha. The increase in yield from the application of mineral fertilizers was 7.04 t/ha in the first case and 14.0 t/ha in the second (Table 3).

Table 3

Yields of green mass of cabbage crops, t/ha (average for 2018-2019)

Crops	Level of mineral nutrition		
	Without fertilizer (control)	$N_{30}P_{30}K_{30}$	$N_{60}P_{60}K_{60}$
Spring rape	20,1	27,5	34,1
White mustard	19,6	25,1	32,3
Oil radish	18,4	23,9	30,8

$HIP_{05\ (t/ha)}$: A – 1,85; B – 0,20; AB -3,21.

The maximum yield of green mass of white mustard was noted in the variant with the application of mineral fertilizers at a dose of $N_{60}P_{60}K_{60}$ and was 32.3 t/ha, which is 12.7 t/ha more than control. Application of mineral fertilizers at a dose of $N_{30}P_{30}K_{30}$ contributed to the formation of 25.1 t/ha of green mass, 5.5 t/ha exceeded the control. At the same time, the yield of green mass of white mustard was 19.6 t/ha on the variant without fertilizer.

Studies have shown that the yield of green mass of oil radish was small on the option without fertilizers and amounted to 18.4 t/ha. The application of 30 and 60 kg of the main macro fertilizer in pre-sowing cultivation, contributed to a significant increase in productivity. At the variant with $N_{30}P_{30}K_{30}$ application the yield of oil radish was 23,9 t/ha, and with $N_{60}P_{60}K_{60}$ it was 30,8 t/ha. At the same time, there was an increase in the yield of green mass of oil radish compared to the control by 5.5 and 12.4 t/ha, respectively.

Dry matter of each crop, including spring cabbage crops, contains accumulated nutrients, mineral elements and vitamins. Therefore, its quantity also largely determines the fodder value of the plants. Consequently, it is important not only to ensure a higher green matter yield, but also a high content of absolute dry matter in the green fodder. Dry matter accumulation also depends on the biological characteristics of crops, the duration of their vegetation period, as well as on external factors, of which water and nutrient regimes of the soil have the greatest influence on this process.

As a result of field researches, it has been established that a yield of dry matter from spring rape sowings was 2.8 t/ha - at the variant without fertilizers, 3.8 t/ha - at the variant with mineral fertilizers in a dozen $N_{30}P_{30}K_{30}$ and 4.7 t/ha - at the variant with mineral fertilizers in a dozen $N_{60}P_{60}K_{60}$, the gain of dry matter to the control at the variants with fertilizers was 1.0 and 1.9 t/ha.

At cultivation of white mustard without use of fertilizers (control) the yield of dry matter was 2.8 t/ha. There was an increase in the yield of dry matter in mustard by 0.7 t/ha compared to the control to 3.5 t/ha - at the option with the application of $N_{30}P_{30}K_{30}$. Increasing the dose of mineral fertilizer twice contributed to the formation of 4.5 t/ha dry matter of white mustard (Table 4).

Table 4

Dry matter yield of cabbage crops, t/ha (average for 2018-2019)

Crops	Level of mineral nutrition		
	Without fertilizer (control)	$N_{30}P_{30}K_{30}$	$N_{60}P_{60}K_{60}$
Spring rape	2,8	3,8	4,7
White mustard	2,8	3,5	4,5
Oil radish	2,6	3,4	4,4

$HIP_{05\ (t/ha)}$: A-0,07; B-0,11; AB – 0,12.

An herbage on the variants with fertilizer compared to the control variant was noted. Thus, when applying $N_{30}P_{30}K_{30}$ the yield of dry matter increased by 0.8 t/ha to 3.4 t/ha, and when applying $N_{60}P_{60}K_{60}$ it rose to 4.4 t/ha.

Thus, the application of mineral fertilizers at a dose of $N_{60}P_{60}K_{60}$ ensures the formation of high performance of spring cabbage crops. At the same time, spring rape crops formed 34.1 t / ha of green mass with an output of 4.7 t/ha of dry matter. The white mustard and oil radish yield 32.3 and 30.8 t/ha of green matter, yielding 4.5 and 4.4 t/ha of dry matter.

The green matter of cabbage crops is known to be rich in mineral nutrients. Among individual minerals, phosphorus takes a significant share, whose content decreases by the end of the growing season, and in the phase of fruit formation is 2.4-8.0 g, the maximum concentration of phosphorus (9.0-13.3 g) is noted in the phase of flowering. The amount of calcium in green mass is relatively high and reaches especially high levels in young plants (11.2-26.2 g). Its content decreases almost twofold during the phase of fruit formation.

The green mass of cabbage plants, especially at the beginning of the flowering phase, contains significant amounts of such elements as copper, zinc, manganese, sodium, magnesium. Cruciferous crops occupy first place among annual plants by the complex of nutrients. They successfully compete with legumes in terms of protein content in absolutely dry mass.

Studies have established that a feature of the qualitative composition of cabbage crops is a high protein and fat content. At the beginning of flowering phase 1 kg of dry matter contains 19.1-20.5% raw protein and 3.7-5.0% raw fat.

Characterizing each crop separately, it should be noted that the crude protein content of spring rape in the variant without fertilizers was at the level of 19.1%. At application of mineral fertilizers, it grew to 19,4% - in the variant with $N_{30}P_{30}K_{30}$ and 19,6% - in the variant with $N_{60}P_{60}K_{60}$ (table 5).

The content of crude protein in 1 kg of dry matter of white mustard depending on the level of mineral nutrition was within the range 19,6-20,5%, whereas in oil radish - 19,5-20,0%.

It was noticed that crude fibre content of cabbage plants at the variant without fertilizer was within the range of 19.7-24.0 %, at application of $N_{30}P_{30}K_{30}$ - 19.5-23.7 %, whereas at application of $N_{60}P_{60}K_{60}$ - 19.2-23.2 %.

The content of ash elements in 1 kg of dry matter of cabbage plants depended to a greater extent on the level of mineral fertilization and varied from 12.1 to 15.4%.

In variants without mineral fertilizers, the content of crude fat in dry matter was 3.7-4.6%. When 30 kg a.d. of basic macrofertiliser was applied, it increased to 3.9-4.8%. Doubling the dose of mineral fertilizer helped to produce 4.1-5.0% fat in dry matter.

Table 5

Qualitative composition of dry matter in cabbage crops, (average for 2018-2019)

Level of mineral nutrition	Culture	Content in 1 kg dry matter, %				
		Crude protein	Crude fibre	Crude ash	Crude fat	NFA
Without fertiliser (control)	spring rape	19,1	19,7	12,1	4,6	44,5
	white mustard	19,6	21,7	14,8	3,7	40,2
	oil radish	19,5	24,0	13,3	4,3	38,9
$N_{30}P_{30}K_{30}$	spring rape	19,4	19,5	12,2	4,8	44,1
	white mustard	19,9	21,5	14,8	3,9	39,9
	oil radish	19,7	23,7	13,9	4,5	38,2
$N_{60}P_{60}K_{60}$	spring rape	19,6	19,2	13,4	5,0	42,8
	white mustard	20,5	21,4	15,4	4,1	38,6
	oil radish	20,0	23,2	14,6	4,6	37,6

In general, the nitrogen-free extractive matter (NFA) content was 37.6-44.5% on a dry matter basis.

One of the important characteristics of the feed is its nutritive value, i.e., its content of digestible protein and feed units.

Digestible protein is the complex of nitrogenous substances in the feed. The majority of protein is protein, which animals should receive with feed.

Digestible protein is the fraction of crude protein that is absorbed into the blood and lymph from the digestive tract. Therefore, this indicator describes the total amount of nitrogen lost from the digestive tract, but

does not determine what form of nitrogen has been absorbed as ammonium or amino acids.

Feed Unit - A unit of measure of the total nutritive value of feed. Feeding rates for farm animals are calculated on the basis of feed units. An indicator of the nutritive value of feed can also be the amount of metabolizable energy contained in it.

It is known that cattle are the main consumers of green forage from the spring cabbage fodder, therefore, we determined the digestibility for this group of animals. Thus, the content of metabolizable energy in 1 kg of dry matter was, depending on the level of mineral provision of cabbage crops 9,6-10,1 GJ.

It is noted that the content of digestible protein in 1 kg of dry matter of cabbage was 127.5-131.1 g in the control variant. At the dose of $N_{30}P_{30}K_{30}$ application of mineral fertilizers it rose to 129.7-133.3 g. The content of digestible protein was high at the variant of $N_{30}P_{30}K_{30}$ application and reached 131.1-134.0 g.

The calculations revealed the effect of mineral fertilizers on the content of fodder units in 1 kg of dry matter. Thus, in the variant without fertilization the content of fodder units of cabbage crops was at the level of 0.91-0.98 kg per 1 kg of dry matter. When 30 kg a.d. of basic macro fertilizer was applied, it was 0.91-0.97 kg. Increasing the dose of mineral fertilizers twice contributed to the formation of 0,91-0,94 kg of fodder units per 1 kg of dry matter.

It was found that the provision of 1 fodder unit of digestible protein depended on both the levels of mineral nutrition and the cabbage crop. Thus, in spring rape it was 130,1-139,5 g, in white mustard 144,1-151,2 g and in oil radish 141,7-147,3 g.

On the basis of the two-year observation of the growth and development of spring rape, white mustard and oil radish plants depending on the influence of the levels of mineral nutrition a number of conclusions can be made.

The addition of $N_{60}P_{60}K_{60}$ to the pre-sowing cultivation contributes to prolongation of the interphase periods of spring cabbage crops by 7-14 days comparing to the control.

There was an increase of the height of the plants after application of 60 kg a.d. fertilizer in spring rape, 34,1 cm in white mustard and 30,1 cm in oil radish as compared to the control.

Optimization of the conditions of mineral nutrition provides formation of 34.1 t / ha of green mass of spring rape with yield of 4.7 t / ha of dry matter. The white mustard and oilseed rape crops produce 32.3 and 30.8 t/ha of green matter, with yields of 4.5 and 4.4 t/ha of dry matter.

The content of crude protein in 1 kg of dry matter of white mustard depending on the level of mineral nutrition was in the range of 19.6-20.5%, in oil radish - 19.5-20.0%, and in spring rape - 19.1-19, 6%.

Thus, the positive role of mineral fertilizers, especially their application at the dose of $N_{60}P_{60}K_{60}$ on the indicators of quality and nutritive value of forage from spring cabbage crops was noted.

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