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INFLUENCE OF CHLORMEQUAT CHLORIDE ON MORPHOGENESIS, FORMATION OF DONOR-ACCEPTOR SYSTEM AND PRODUCTION PROCESS OF OIL CROPS

Introduction. One of the auspicious approaches in solving the issues of directed regulation of growth and development, redistribution of photosynthetic streams from vegetative growth for the needs of the formation of fruits and seeds is the correction of the donor-acceptor relationship of the plant (concept "source-sink"), which is provided by different regulatory mechanisms [1, 2 , 3]. This conception is used for the analysis either a heterotrophic phase of growth (seed germination under the influence of light and in the dark, under the influence of various classes of phytohormones or abiotic environmental factors [4, 5], or in the analysis of the ratio of intensity of photosynthesis and growth processes, where photosynthesis acts as the main donor, and growth is the main acceptor of assimilates [6, 7]. The correlation between the donor and acceptor spheres of the plant can be artificially modified, by increasing or decreasing the intensity of photosynthesis and growth by morphophysiological changes – forming a powerful leaf surface and an effective mesostructure [8, 9], accelerating the formation of the photosynthetic apparatus and extending the life of the leaves as the main donor of assimilates [1, 10, 11]. Elseways, the efficiency of the functioning of this system depends on the power of acceptor centres, the formation of the "demand" for assimilates [1, 12].

One of the most influential acceptors of photosynthesis products is plant growth zones and processes of fruit formation and growth (carpogenesis) [6]. An increase in the number of fruits leads to an increase in the traction ability of these zones, and an appropriate redistribution of flows of assimilates from vegetative growth to fruit formation and growth. In order to change the growth intensity of individual organs (and thus their acceptor potential), exogenous hormones and growth regulators are widely used to simulate different degrees of tension in the donor-acceptor system [3, 13, 14]. Insomuch as plant growth regulators have an important effect on morphogenesis, it is possible to establish through which anatomical-morphological and physiological changes the transport of flows of assimilates to different organs and tissues of the plant increases or weakens. This approach allows establishing not only the redistribution of photosynthesis products between the vegetative and generative organs of the plant, but also the mineral elements between them at different growth rates.

One of the most accepted groups of synthetic plant growth regulators is retardants. These are synthetic substances that are used to inhibit growth processes [13, 15], accelerate the transition to rest [6], increase the resistance of plants to adverse environmental factors [16, 17]. These preparations are inevitably different in their chemical structure, but cause the same effect – slowing the division and stretching of cells, which leads to inhibition of growth in general, without causing abnormal deviations. With sufficient activity of the assimilation apparatus, the artificial limitation of the growth of vegetative organs under the influence of retardants leads to the redistribution of assimilates towards fruit formation, resulting in often increased yields and improving the quality of crops [14, 18, 19, 20]. Nonetheless, the question of physiological mechanisms of coordination of growth retardation and plant productivity improvement under the action of retardants is not sufficiently studied. It is already known that the physiological effect of the preparations of this group is carried out either by blocking the synthesis of gibberellins in the plant or by blocking the formation of the hormone receptor complex, and therefore the effect of the already synthesized gibberellin is not realized [21, 22]. The typical representative of the retardants is chlormequat chloride (CCC) – $[Cl\text{-}CH_2\text{-}CH_2N\ (CH_3)\ _3]^+Cl^-$. At the same time, the peculiarities of chlormequat chloride influence on morphological, mesostructural and physiological-biochemical components of the donor-acceptor system of agricultural plants are insufficiently studied. The data on the influence of this and other retardants on morphogenesis and oil crop productivity are negligible and contradictory [23, 24, 25]. In this regard, the purpose of this study was to determine the effect of chlormequat chloride on morphogenesis, peculiarities of the formation and functioning of donor-acceptor relationships in oil crops.

1. Features of morphogenesis of plants of oil crops under the action of growth inhibitors

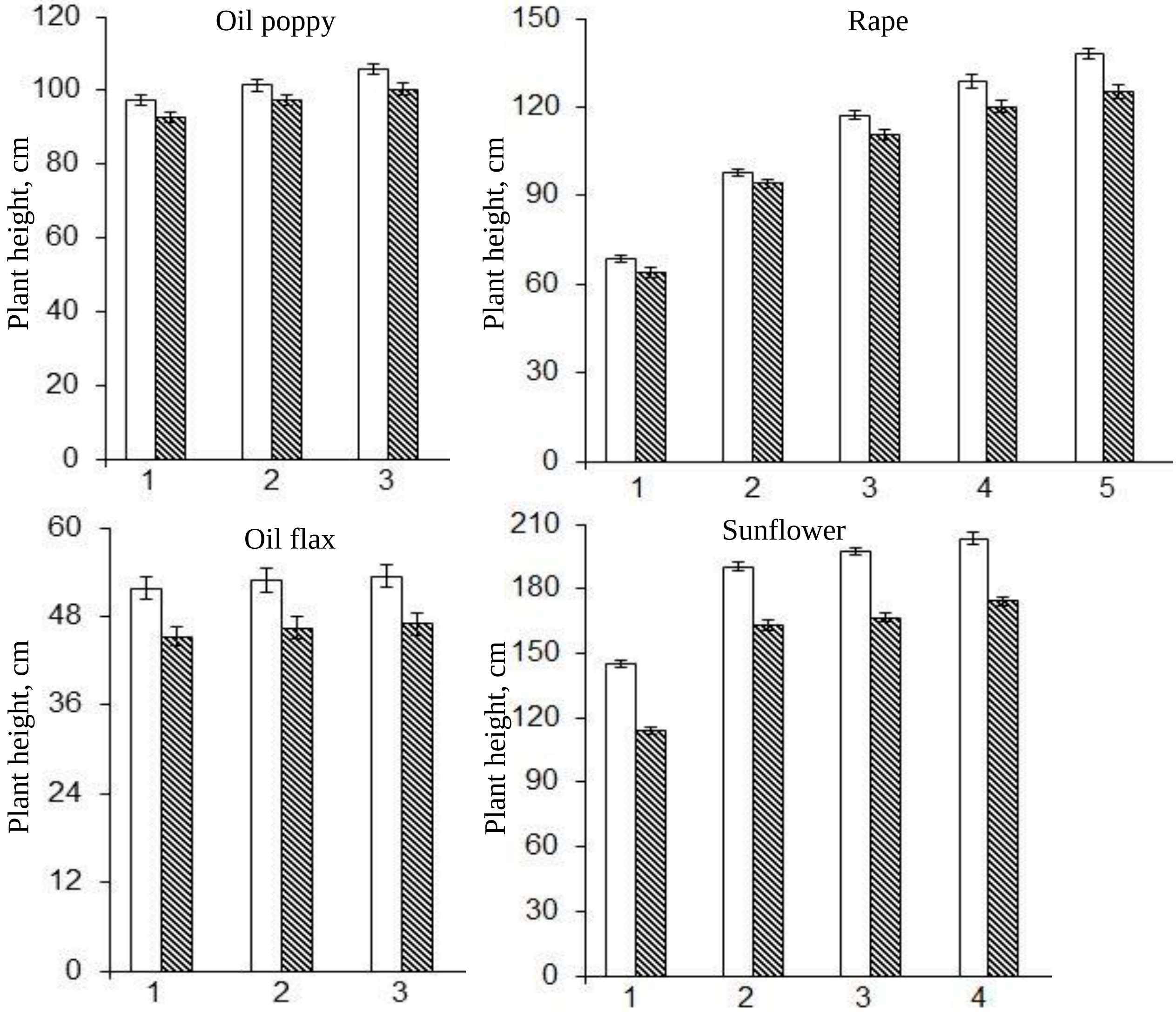
It is acknowledged that the regulation of donor-acceptor relations in the system of an entire plant is carried out through the coordination of photosynthesis and growth function, and any natural or experimental changes in the rate of growth processes are accompanied by an adequate reorganization of the photosynthetic apparatus [1]. The use of growth regulators can influence the morphometric indices of parts of the plant organism, causing a possible redistribution of flows of assimilates to economically important tissues and organs [27].

One of the most important morphometric indices of the plant is its linear dimensions. Literary sources contain sufficient information on the effect of growth inhibitors on plant growth, duration and intensity in different crops [28, 29].

Biometric indices of plants are also influenced by growth inhibitors. One of the most used retardants in the group of ammonium compounds, CCC, inhibited the growth of soybean [30], potatoes [31, 32], and sunflower plants [33, 34].

The scientific literature has works containing information on the influence of growth regulators on the linear sizes of oil crops, but they are rather controversial [35, 36]. Accordingly, one of the objectives of the paper was to study the influence of quaternary ammonium salt on the morphometric and anatomical characteristics of sunflower, poppy, flax and rape plants.

The results of our studies reveal that the growth inhibitor of plants with antigiberellin mechanism of action – chlormequat chloride significantly inhibited the growth of plants of the cultures under investigation, which is a typical reaction of plants to the effects of retardants (Fig. 1).

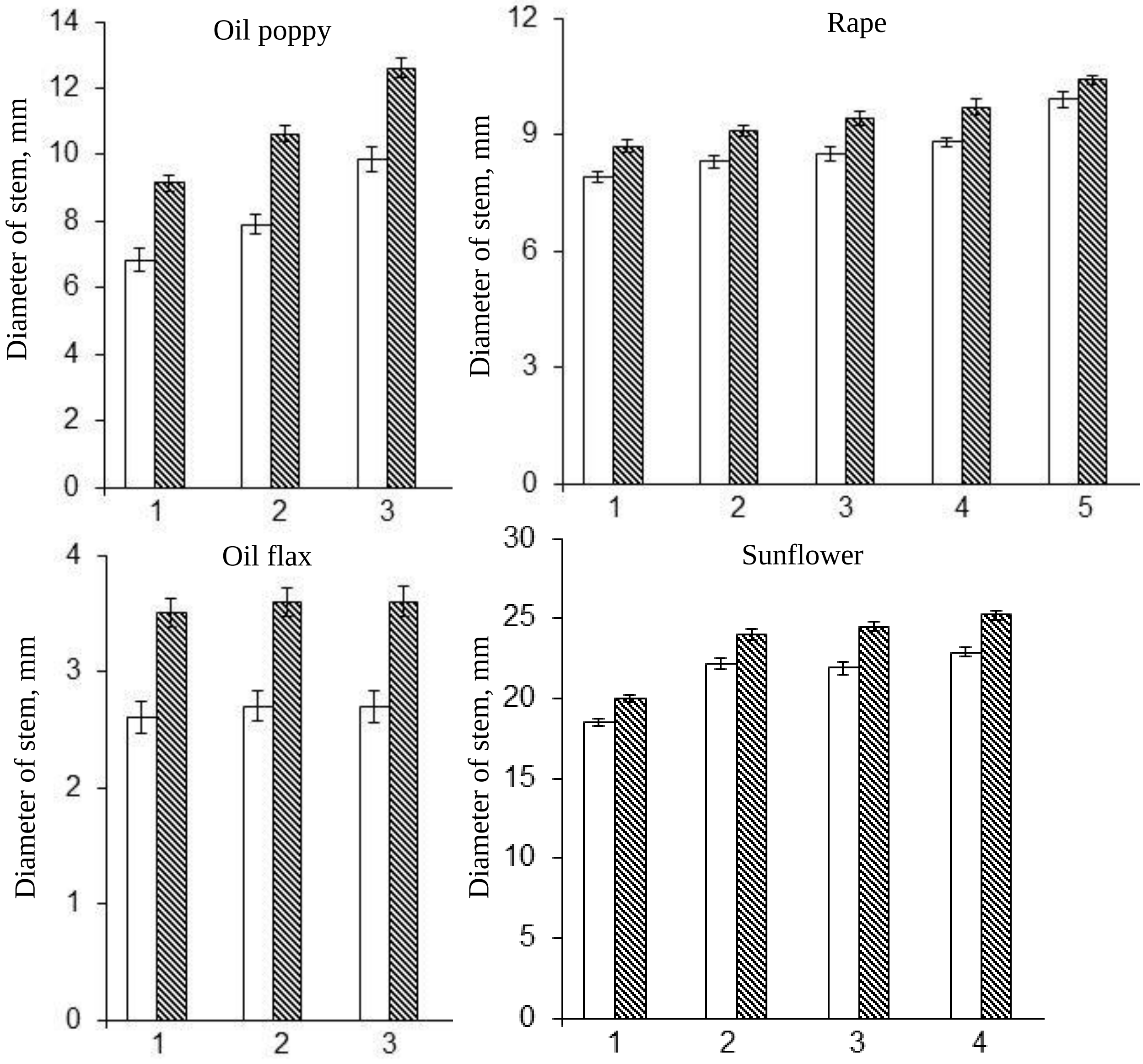


□ – control, ▧ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 1. Influence of chlormequat chloride on the height of oil poppy plants, oil flax, winter rape, sunflower

The vast majority of agricultural crops of field crop rotation is characterized by lodging of crops [37]. In the scientific literature, there is enough information on the use of anti-gibberellins to prevent the emergence of crops, mainly cereals [38, 39]. This problem is also relevant for oil crops [40], including sunflower, canola, flax and poppy plants.

The analysis of the obtained results shows that the use of the growth inhibitor resulted in thickening of the stems of experimental plants (Fig. 2). Most significantly, the diameter of the stem increased with the use of chlormequat chloride at the end of vegetation in the oil poppy plants on average by 27%.

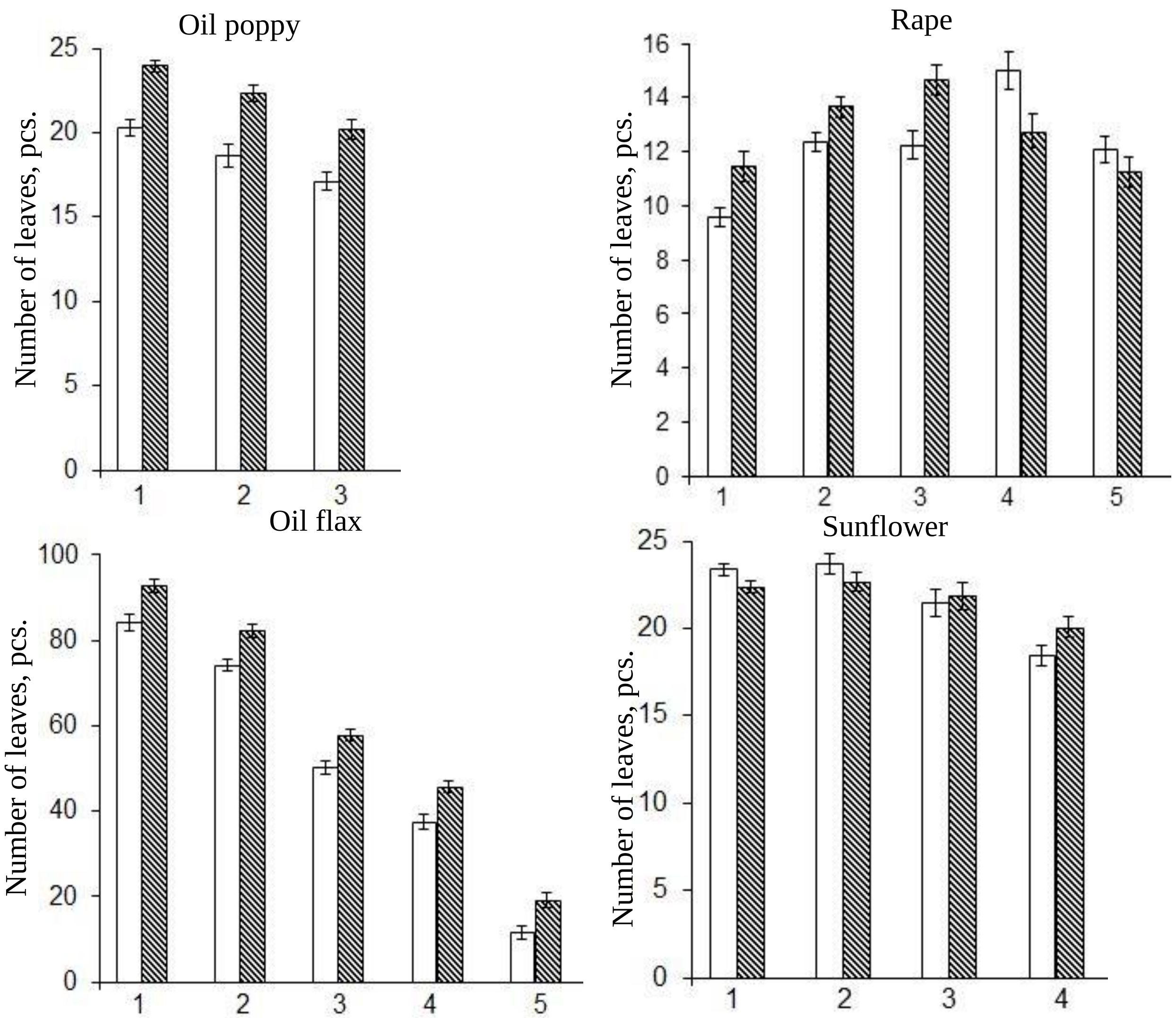


□ – control, ▨ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 2. Influence of chlormequat chloride on the diameter of the stem of oil poppy plants, oil flax, rape, sunflower

It is known that the plant production process is largely determined by the peculiarities of the formation of the development of the leaf apparatus [1, 41]. In this regard, we reckon that it was necessary to establish the peculiarities of the formation of the leaf surface of poppy, sunflower, flax and rape plants under the action of an anti-gibberellin preparation.

The obtained results indicate that there was a considerable difference in the number of leaves, their area between the plants of the experimental variant and the control one. By the end of the entire growing season under the influence of the growth regulator, the number of leaves in oil poppy, flax and sunflower plants in the experimental version was greater than in the control variant (Fig. 3).



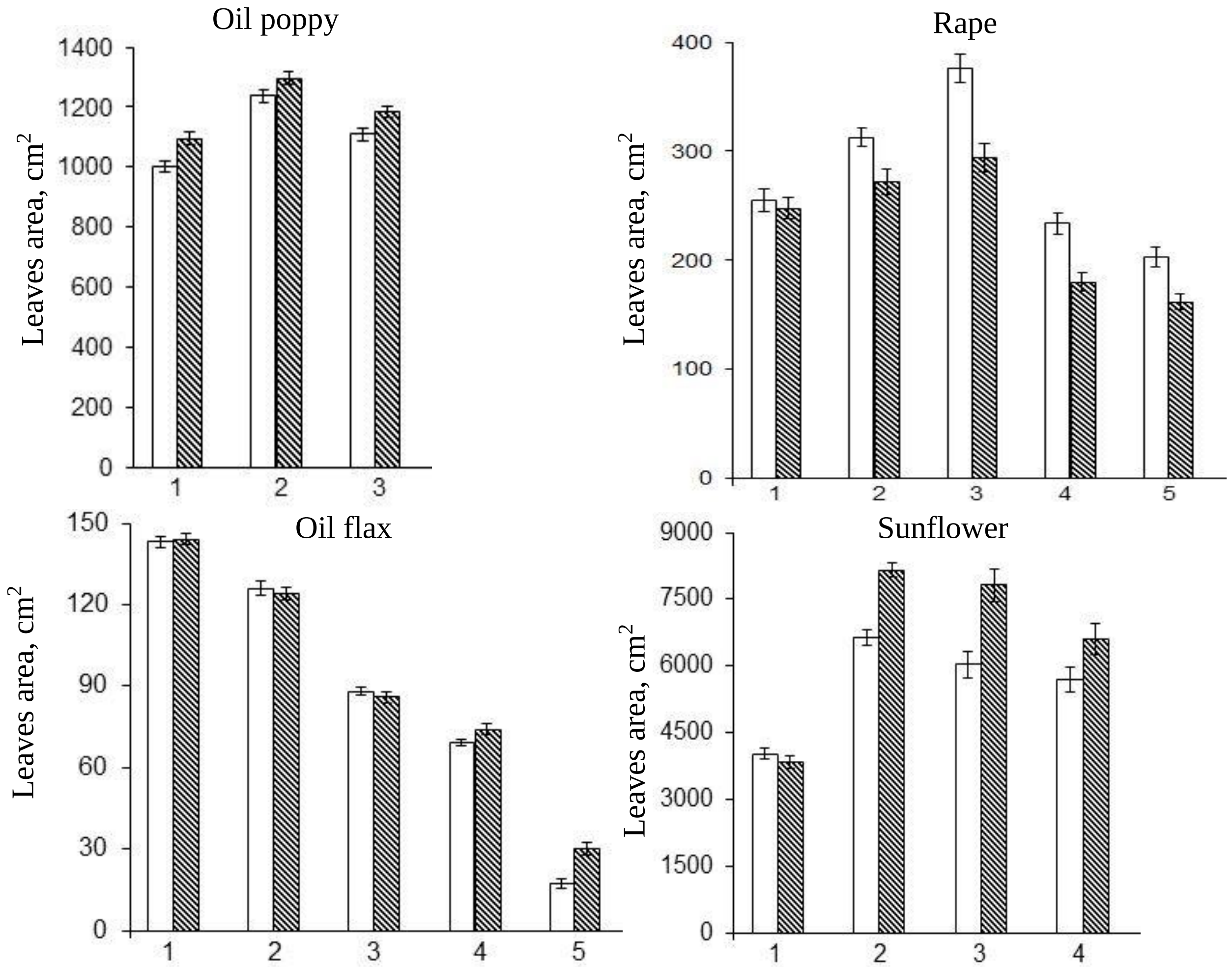
□ – control, ▨ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 3. Influence of chlormequat chloride on the number of leaves of oil poppy plants, oil flax, rape, sunflower

However, the application of retardant to the rape plant was accompanied with a decrease in the number of leaves.

The area of the leaf surface plays a significant role in the formation of plant productivity [1]. Literary data indicate that retardants affect the leaf area. Application of chlorocholin chloride on sugar beet plants [42, 43] led to a decrease in the area of the leaf surface.

The results of our studies show that the use of the retardant influenced the area of the leaf surface of plants under investigation (Fig. 4).



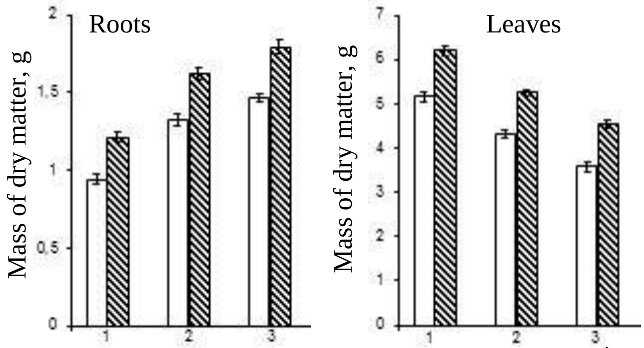
□ – control, ▧ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 4. Influence of chlormequat chloride on the leaf area of oil poppy plants, oil flax, rape, sunflower

Notably, under the action of chlormequat chloride, an increase in the total leaf area occurred at the end of vegetation in oil poppy, oil flax and sunflower plants in relation to the control variants. However, the use of quaternary ammonium salt on winter rape plants led to a decrease in leaf area relative to the control variant.

We have found that the growth of the total area, number and weight of leaves in poppy and flax plants is primarily ensured by the process of more intensive stem branching. Strengthening the stem branching under the action of retardants is a general reaction of plants to the action of antigibberellin preparations – retardants, as it was noted earlier in a wide range of cultures [6, 12].

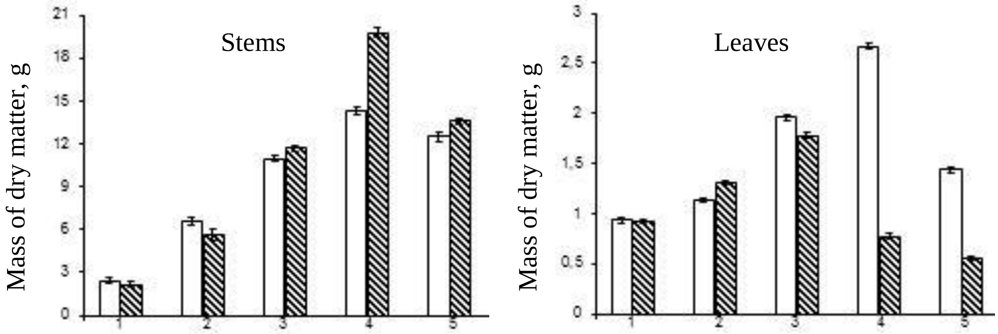
The change in the intensity of growth processes in oil poppy plants under the influence of chlormequat chloride was accompanied by a change in the accumulation of the mass of dry matter of the plant organs (Fig. 5). The obtained research results indicate that the mass of dry matter of the roots and leaves of poppy plants increased with the use of the retardant.



□ – control, ▧ – chlormequat chloride. Sampling dates: 1-3 – 10-, 20-, 30th day after treatment

Figure 5. Influence of chlormequat chloride on the accumulation of dry mass by vegetative organs in oil poppy plants

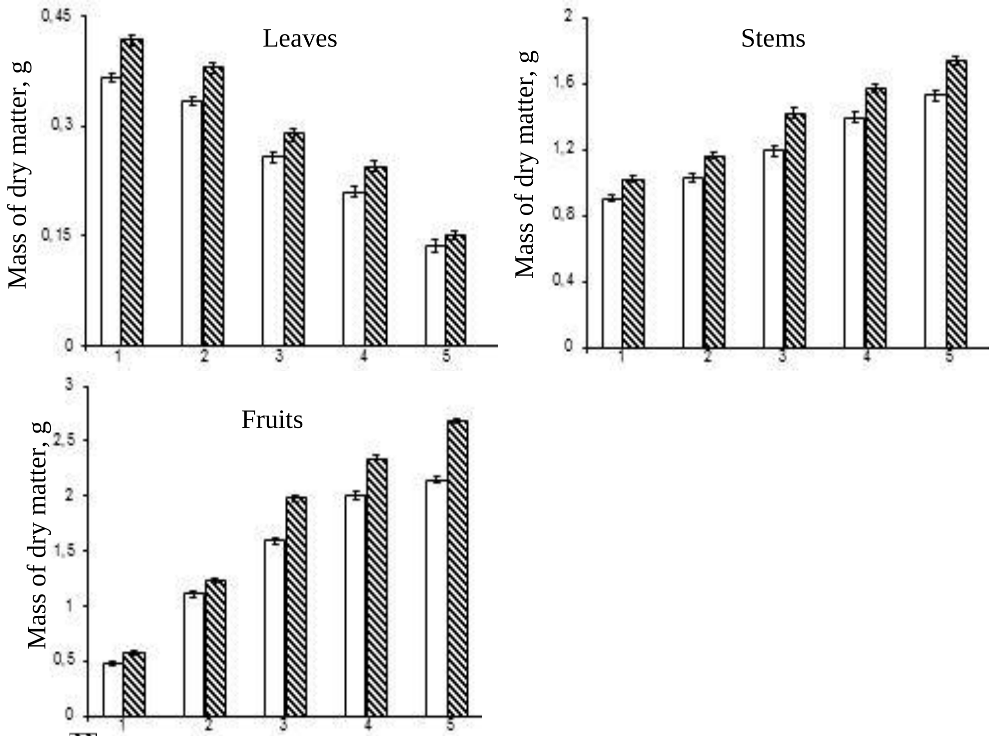
Similarly, the mass of stems in winter rape plants was increased in the variant using the antigibberellin preparation (Fig. 6).



□ – control, ▧ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 6. Influence of chlormequat chloride on the accumulation of dry weight by vegetative organs in winter rape plants

Similar research results of the chlormequat chloride influence on the culture of oil flax were obtained. The mass of dry matter of leaves, stems and fruits increased with the use of the retardant (Fig. 7).

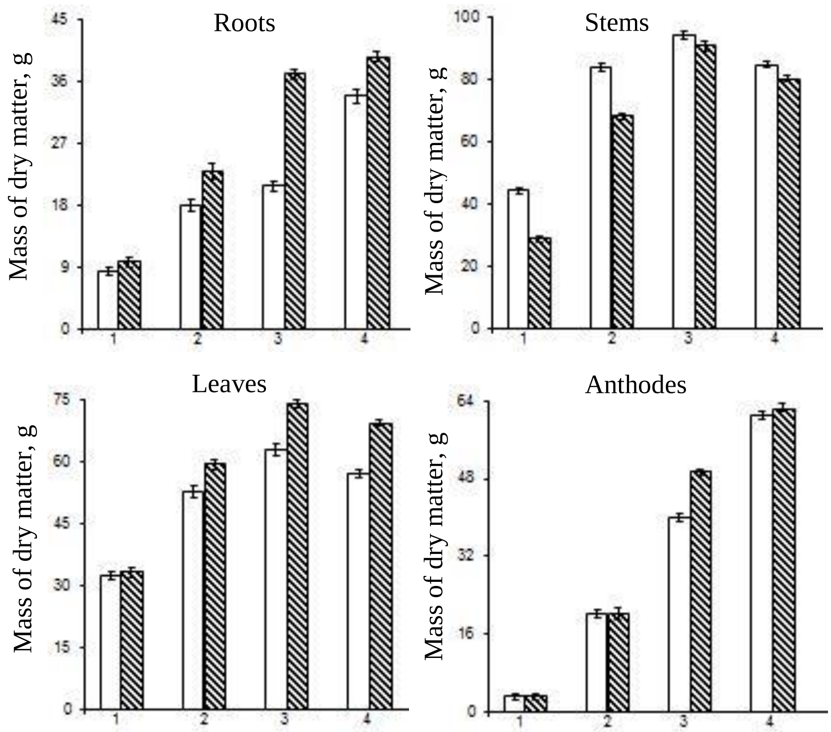


□ – control, ▧ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50^{th} day after treatment

Figure 7. Influence of chlormequat chloride on the accumulation of dry mass by vegetative and generative organs in oil flax plants

In sunflower plants treated with the growth regulator, there was an increase in the mass of dry matter of the roots, leaves and anthodes during the entire period of vegetation compared to the control variant (Fig. 8). However, the application of antigibberellin preparation leads to a decrease in the mass of dry matter of the stem. Analogous results are obtained on sunflower plants under the effect of cycocel [34].

The physiological state of the leaf is in close interaction with its structural features, which are defined in the scientific literature as a "mesostructure". The application of mesostructure characteristics allows analyzing the photosynthetic function of the leaf in many cases, but in the study of retarded effects, it was rarely used.



□ – control, ▧ – chlormequat chloride. Sampling dates: 1-4 – 10-, 20-, 30-, 40th day after treatment

Figure 8. Influence of chlormequat chloride on the accumulation of dry matter by vegetative and generative organs in sunflower plants

The results of our study of elements of the mesostructure testify to the fact that the thickness of the layer of chlorenchyme (Table 1) increased significantly under the action of chlormequat chloride in the studied plants. Similar results were obtained in potato and soybean cultures [32, 45, 46].

Table 1. Effect of chlormequat chloride on the leaf mesostructure of poppy, flax, sunflower, rape plants

Indicators	Control	CCC
Oil poppy		
Thickness of the leaf blade, µm	233,3±5,91	*289,09±5,49
Thickness of chlorenchyma, µm	127,5±2,93	*177,21±2,37
Length of parenchyma cell, µm	43,7±0,92	*54,5±1,13
Width of parenchyma cell, µm	22,9±0,84	*35,4±0,76
Oil flax		
Thickness of the leaf blade, µm	144,7±1,5	*170,7±3,4
Thickness of chlorenchyma, µm	119,22±1,4	*134,39±3,54
Cell volume of the columnar parenchyma, μm^3	3824±171	*5327±196
Cell width of the spongy parenchyma, µm	19,4±0,7	17,5±0,8
Cell length of the spongy parenchyma, µm	16,2±0,6	14,2±0,6

Sunflower		
Thickness of the leaf blade, µm	200,15±5,16	211,70±3,52
Thickness of chlorenchyma, µm	162,18±3,59	*173,12±2,08
Cell volume of the columnar parenchyma, $µm^3$	4950,15±209,42	*5647,39±231,37
Cell width of the spongy parenchyma, µm	11,97±0,37	11,62±0,49
Cell length of the spongy parenchyma, µm	16,10±0,48	*14,32±0,37
Rape		
Thickness of the leaf blade, µm	228,58±2,35	*283,76±2,57
Thickness of chlorenchyma, µm	185,69±6,46	*230,63±2,39
Cell volume of the columnar parenchyma, $µm^3$	1355,72±25,91	*1436,61±27,26
Cell width of the spongy parenchyma, µm	13,25±0,70	*22,10±1,04
Cell length of the spongy parenchyma, µm	18,69±0,72	21,55±1,35

Note: *- the difference is reliable at P≤0.05

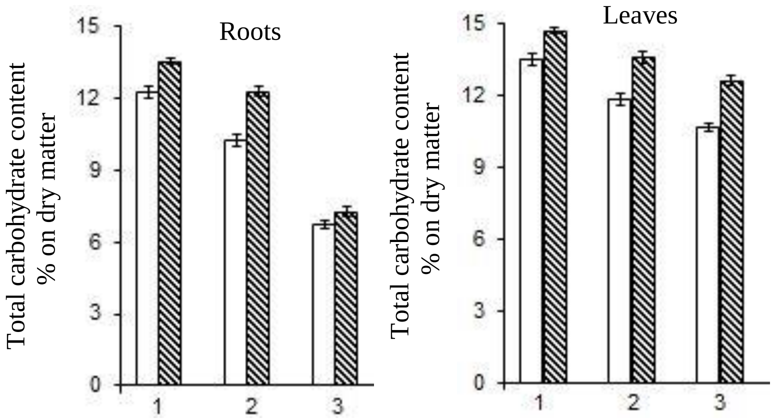
2. Accumulation and redistribution of carbohydrates and nitrogen between plant organs of oil crops in ontogeny under the influence of chlormequat chloride

It is admitted that the action of physiologically active substances leads to the restructuring of the plant assimilation apparatus, the change in habitus, the ratio of masses of its organs, the appearance of additional attracting centers and the strengthening or weakening of the functioning of already existing. It testifies to the changes in the nature of donor-acceptor relationships in plants. Since the essence of these changes in the nature of donor-acceptor relations lies in the redistribution of flows of assimilates between plant organs, it is necessary to have a clear idea of the dynamics of accumulation and distribution of plastic substances in the plant organism for the development of exogenous regulation of ontogenesis by means of growth regulators.

It is established that an increase in the content of carbohydrates in sugar beet root crops was established with the use of paclobutrazole [42, 47]. At the same time, the decrease in the content of sugars in overground vegetative organs of plants was observed under the treatment of black-billed rowan and raspberries with the CCC solution [27], in potatoes under the action of paclobutrazole [31, 48].

The results of our studies indicate that under the influence of growth regulators there are changes in the accumulation and redistribution of carbohydrates between plants of the poppy during the growing season.

In the leaves and roots treated with the retardant, the total content of carbohydrates (sugars and starch) in the experimental variant throughout the growing season was greater than that of the control one (Fig. 9).

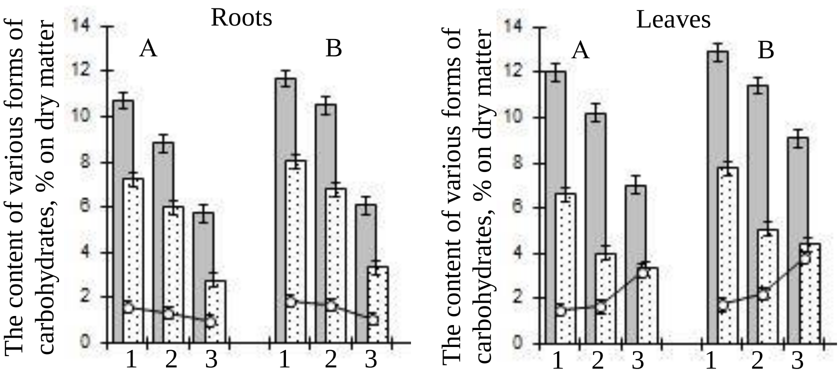


□ – control, ▧ – chlormequat chloride. Sampling dates: 1-3 – 10-, 20-, 30th day after treatment

Figure 9. Influence of chlormequat chloride on the total carbohydrate content (sugar + starch) in vegetative organs in oil poppy plants

The accumulation of excess carbohydrates in the leaves and roots of the experimental variant is of positive significance, forasmuch as a powerful reserve fund of assimilates is being created, which is used to form and grow fruits of oil poppy, the number of which grew.

The analysis of the dynamics of the content of various carbohydrate forms allows us to conclude that there is a gradual reduction of total sugar content due to reducing sugars and the growth of starch content in the poppy leaves both in the control and in the experiment variants during the vegetation (Fig. 10).



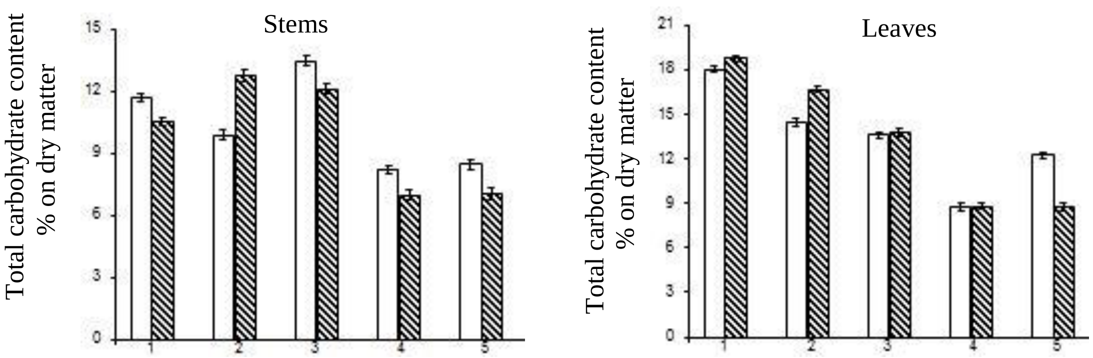
A – control; B – chlormequat chloride ▆ - amount of sugars, ░ - reducing sugars, ▬ - starch. Sampling dates: 1-3 – 10-, 20-, 30th day after treatment.

Figure 10. Effect of chlormequat chloride on the dynamics of the accumulation of various forms of carbohydrates in oil poppy plants

In the roots, there is a decrease in the content of both the amount of sugars and starch. Since after the budding phase the growth processes in vegetative organs are cardinally slowed down, and at the same time there are powerful acceptor zones - pods, the main flow of assimilates is aimed at the formation of the fruits itself, with which the gradual decrease in the content of carbohydrates in vegetative organs is associated.

Thus, under the influence of the growth inhibitor, the donor potential of the leaves of experimental plants increased. Excess carbohydrates was used to form a more powerful plant stems and to the growth of fruits, the number of which grew under the action of chlormequat chloride.

In the leaves and stems of rape plants treated with the retardant, the total carbohydrate content during vegetation was greater than that in the control variant (Fig. 11).

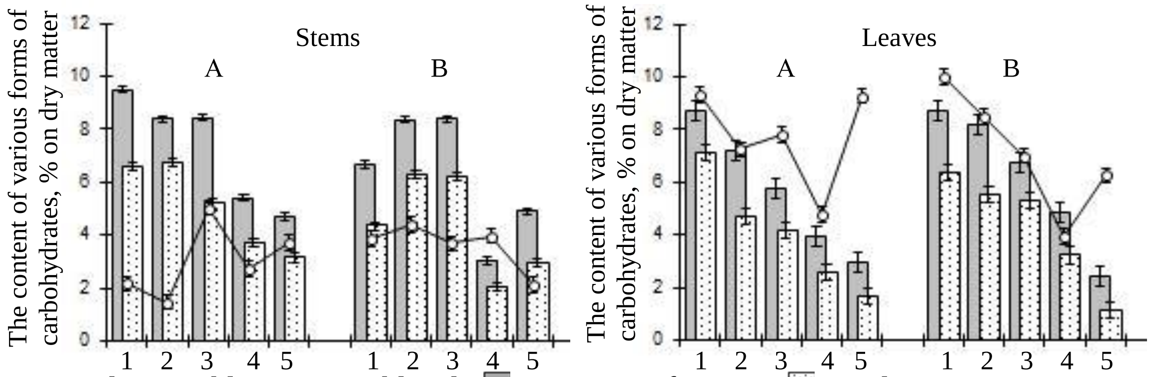


□ – control, ▧ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 11. Influence of chlormequat chloride on total carbohydrate content (sugar + starch) in vegetative organs in winter rape plants.

The analysis of the dynamics of the content of various forms of carbohydrates allows us to sate that there is a gradual decrease in the total content of sugars and starch in leaves and stems of winter rape both in the control and the experiment variants during vegetation (Fig. 12). Since after the budding phase growth processes in vegetative organs are significantly slowed down, and at the same time there are powerful acceptor zones - pods, the main stream of assimilates is aimed at the formation of the fruits itself, with which the gradual decrease in the content of carbohydrates in vegetative organs is associated. Such results are confirmed by other researchers [27].

Our studies indicate that under the action of the retardant there was a decrease in the content of starch in the leaves during the growing season. An increase in the content of starch under the action of the preparation was observed in the stems at the beginning of the vegetation.



A – control; B – chlormequat chloride - amount of sugars, - reducing sugars, - starch. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

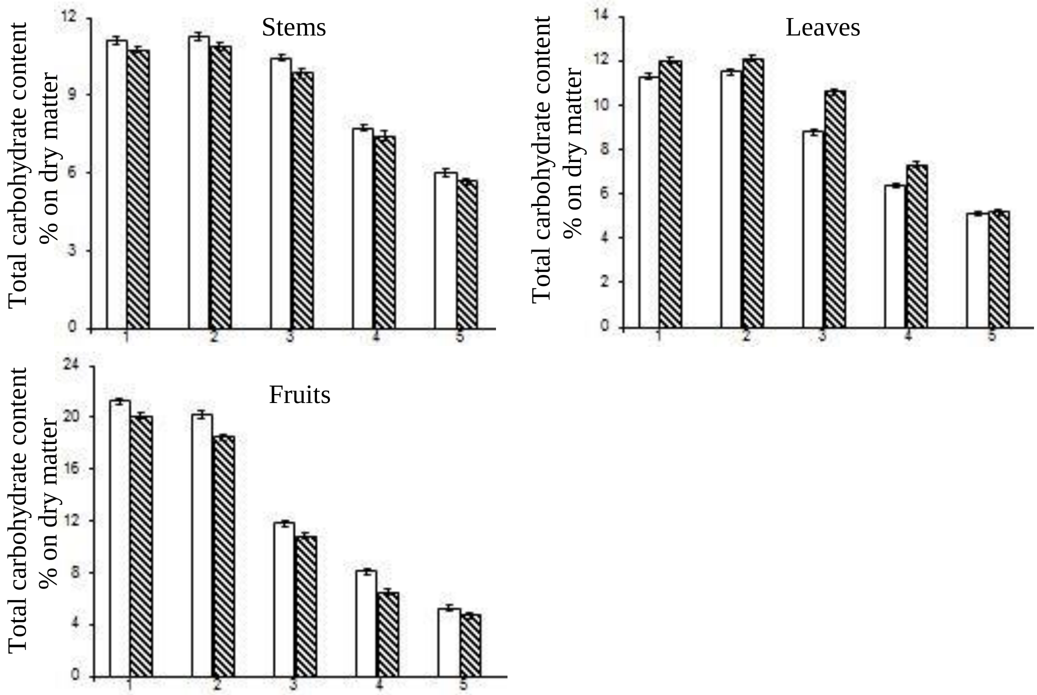
Figure 12. Influence of chlormequat chloride on the dynamics of accumulation of various forms of carbohydrates in winter rape plants

With the beginning of the period of active pod formation, the content of starch in the stem of experimental plants decreased compared with the control variant. In our opinion, this indicates that the decrease in the rate of growth of the plant by the action of retardants leads to the deposit of part of the assimilates in the form of starch. An increase in the content of carbohydrates in the vegetative organs of winter rape under the effects of retardants was also due to the sugars. The growth was primarily by virtue of the accumulation of the main transport form of sugars - sucrose.

Thereupon, the treatment of rape plants with chlormequat chloride was accompanied by the deposition of sugars and starch in tissues of vegetative organs resulted in the decrease in the intensity of their use in growth processes.

The analysis of the obtained results shows that under the influence of the applied growth regulator there are changes in the accumulation and redistribution of carbohydrates between the organs of flax plants during the growing season (Fig. 13).

The total content of carbohydrates (sugars and starch) in the leaves of experimental flax plants during the whole vegetation was greater compared to the control variant in plant stems treated with the preparation, the total carbohydrate content was lower than in the control one.



□ – control, ▧ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

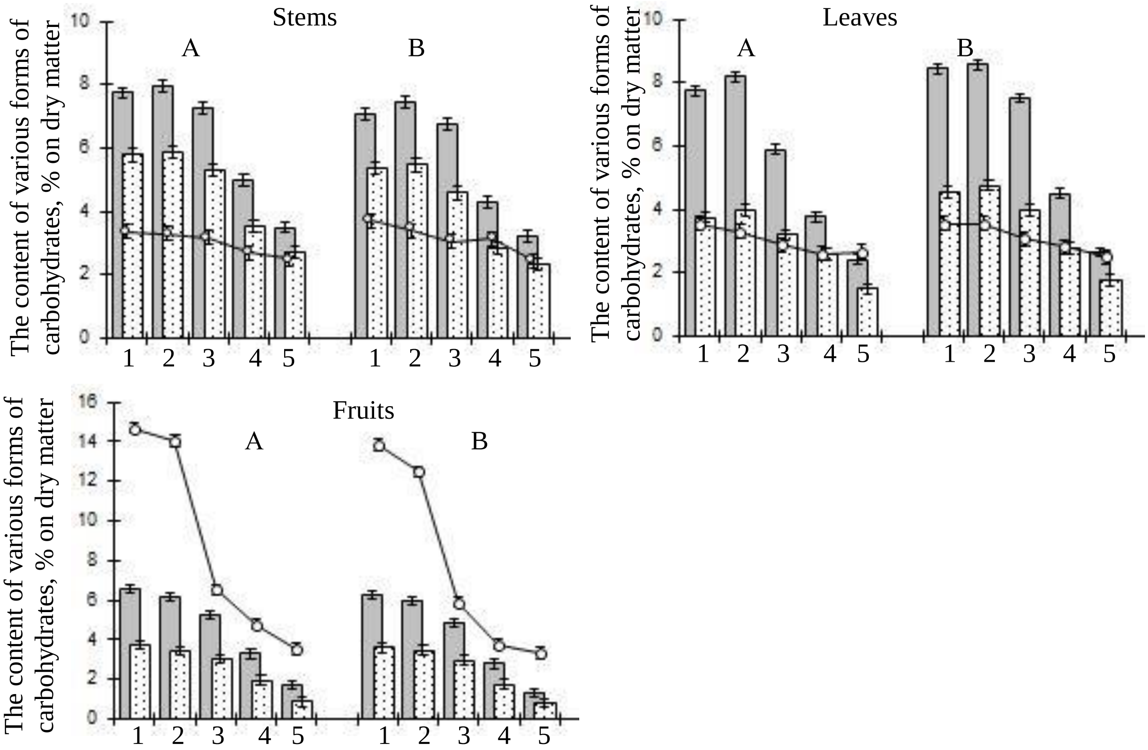
Figure 13. Effect of chlormequat chloride on the total carbohydrate content (sugars + starch) in vegetative and generative organs of oil flax plants

The processes of fruit formation and growth under the action of antigibberellin preparations were accompanied by a significant decrease in the content of free sugars and starch in them.

Figure 14 demonstrates that a gradual decrease in the total content of carbohydrates occurs both at the expense of starch and reducing sugars. During the flowering, formation and infusion of fruits the concentration of starch in vegetative organs decreases by 1-2%. Obviously, this is due to the use of carbohydrates on the biosynthesis of oil in the seeds and the accumulation of protein compounds in the fruits.

Thus, under the influence of growth regulator, the donor potential of leaves of flax plants increased, in which increased content of sugar and starch was observed.

Excess of carbohydrates was used to form a more powerful stem of plants and to the growth of fruits, the number of which increased under the effect of the preparations.

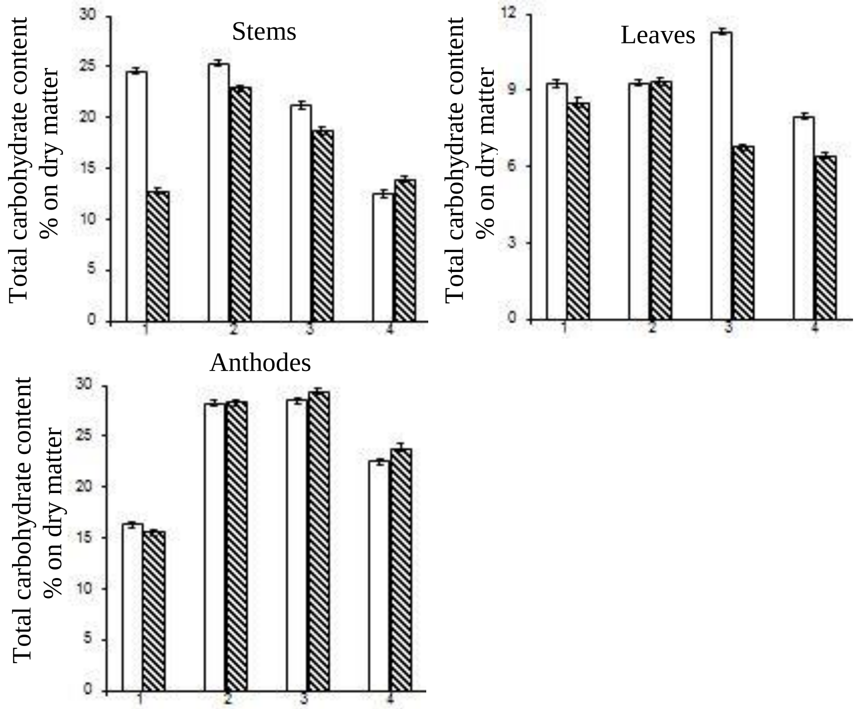


A – control; B – chlormequat chloride - amount of sugars, - reducing sugars, - крохмаль. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 14. Influence of chlormequat chloride on the dynamics of accumulation of various forms of carbohydrates in oil flax plants

The results of our studies reveal that the regulation of sunflower growth under the influence of chlormequat chloride was accompanied by changes in the accumulation and redistribution of different forms of carbohydrates.

The analysis of the dynamics of the content of carbohydrate content allows us to state a rather complex nature of their accumulation and outflow in vegetative organs of sunflower plants under the actions of the retardant. The increase in the content of carbohydrates in the first half of the vegetation in sunflower stems with the subsequent decrease in its tissues at the end of the vegetation, which can, apparently, be explained by the outflow of sugars to the anthodes. Since after their formation growth processes in vegetative organs are mainly slowed down, and later there are powerful acceptor zones - achenes, the main flow of assimilates is directed at the formation of the fruits itself, which is associated with a gradual decrease in the carbohydrate content in the above-ground vegetative organs (Fig. 15).



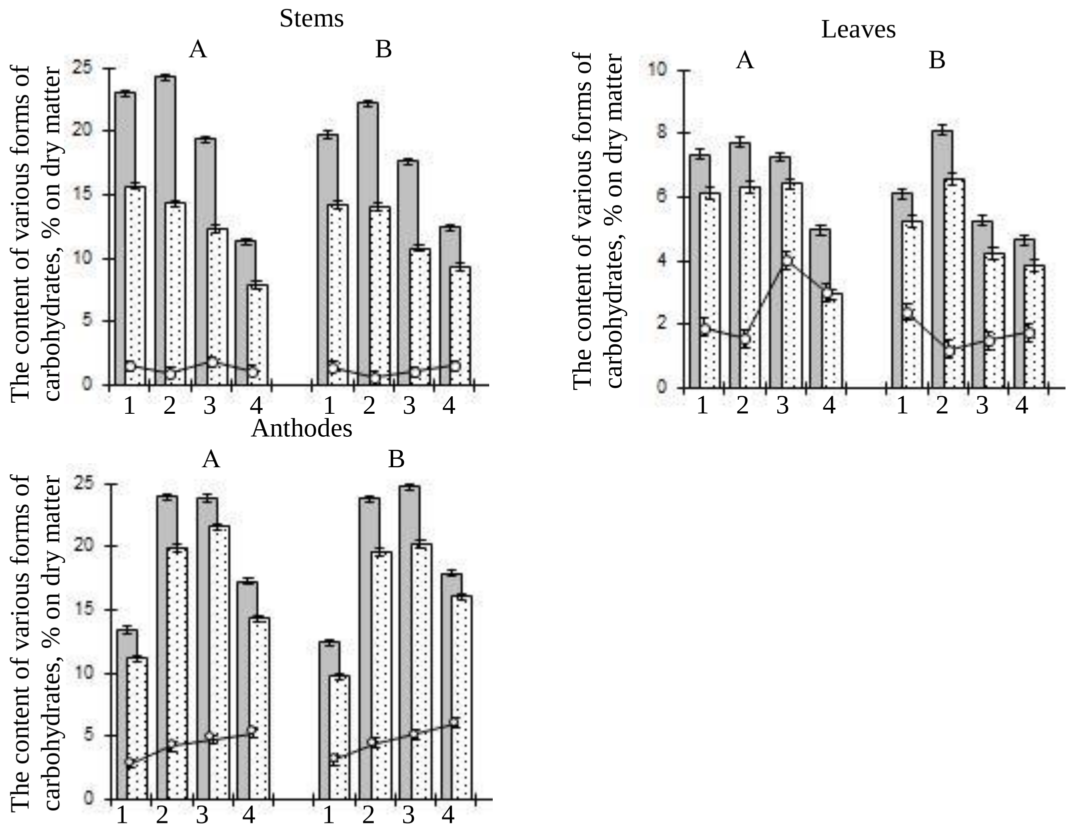
□ – control, ▧ – chlormequat chloride. Sampling dates: 10-, 20-, 30-, 40^{th} day after treatment.

Figure 15. Effect of chlormequat chloride on the total carbohydrate content (sugars + starch) in vegetative and generative organs in sunflower plants

Reduction of carbohydrates in the achenes in the ripening process is associated with an active process of oily formation.

Attention is drawn to the fact that the highest levels of carbohydrate content were observed in the anthodes during the formation and infusion of seeds and the seeds during their formation. The smallest content of carbohydrates is recorded in sunflower leaves, due to their intense outflow to stems and anthodes. The application of retardant chlormequat chloride resulted in increased transport of newly formed compounds to economically important organs.

We found out that the treatment of plants with growth regulators influenced the accumulation and redistribution of sugars and starch between sunflower organs. Carbohydrates in vegetative organs were predominantly in reducing sugars. Particularly high values of this indicator, as well as the content of starch, were recorded in the anthodes with the use of a growth inhibitor (Fig. 16).



A – control; B – chlormequat chloride ▇ - amount of sugars, ░ - reducing sugars, ▬▬ - starch. 10-, 20-, 30-, 40th day after treatment.

Figure 16. Influence of chlormequat chloride on the dynamics of accumulation of various forms of carbohydrates in sunflower plants

The study of the dynamics of starch in the vegetative organs of sunflower carried out by us shows that its smallest content was observed in the stems. During the growing season, there was a decrease in the content of the storage form of carbohydrates.

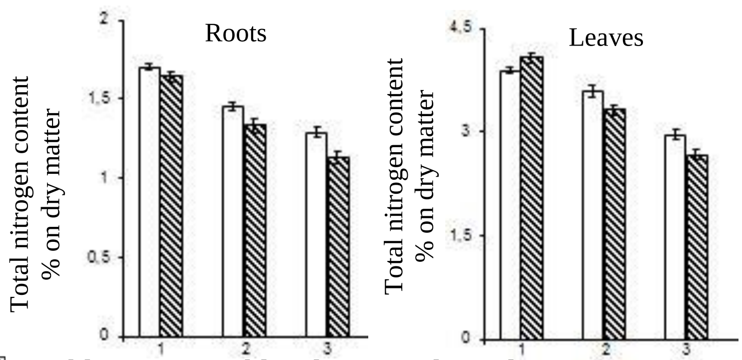
In the leaves the starch content was slightly higher. The maximum values of this indicator were observed at the beginning and at the end of the vegetation. During the seed formation and filling of there was a decrease in the content of starch in the leaves, both in the control and experiment variants. During the entire growing season, the starch content in the anthodes increased.

In leaves and stems of the plants treated with chlormequatchloride, the total sugar content was lower than in the control variant, regardless of the vegetation conditions. We believe, this can be explained by the increased transport of newly formed assimilates to growth and stock zones.

Consequently, the use of chlormequat chloride increased the transport of carbohydrates from leaves and stems to anthodes and seeds, resulting in improved crop productivity.

The data on the effect of growth inhibitors on nitrogen content in oil crops are not numerous [49, 50]. However, it is known that excess nitrogen in tissues during the development of oil crops leads to increased protein accumulation and a simultaneous decrease in the content of oil in the seed and a decrease in the content of unsaturated fatty acids [51, 52].

According to the results of our studies, an increase in the content of carbohydrates in vegetative plant organs of oil poppy under the action of the preparationa (Fig. 17) was accompanied by a decrease in the content of total nitrogen in the roots and leaves in both the control and experimental variants.



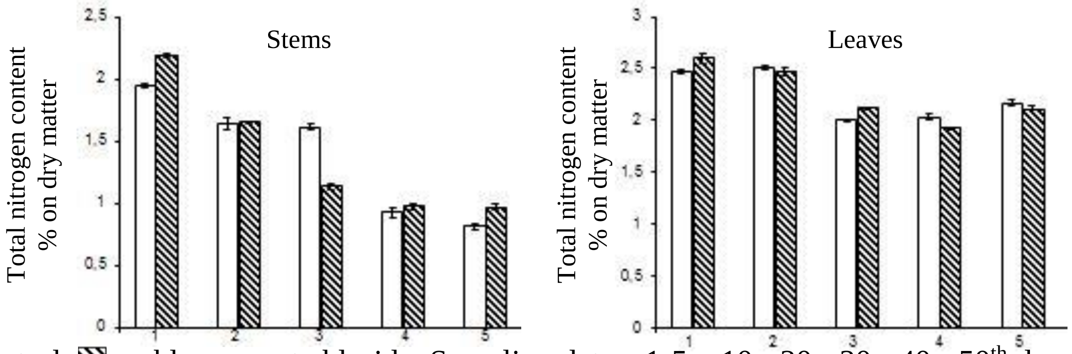
☐ – control, ▧ – chlormequat chloride. Sampling dates: 1-3 – 10-, 20-, 30th day after treatment.

Figure 17. Influence of chlormequat chloride on the content of total nitrogen in vegetative oil poppy plants

The maximum amount of nitrogen-containing substances in the leaves and roots was observed at the initial stages of the study, while the leaves were characterized by a higher content of nitrogen than the roots. The total nitrogen content in the leaves was twice that of the roots. By the end of the vegetation, the nitrogen content in the tissues of the vegetative organs decreased more actively under the influence of the applied growth regulator, which, in our opinion, indicates the intense hydrolysis of proteins and the outflow of nitrogen-containing compounds into new afferent centers - the pods, whose number increases.

Similar results of the outflow of nitrogen from vegetative to generative organs were obtained by us on cultures of flax, winter rape and sunflower.

The results of our studies indicate that the growth of carbohydrate content in vegetative plants of winter rape under the influence of retardant was similarly accompanied by a decrease in the nitrogen content in the leaves (Fig. 18). However, an increase in nitrogen content is observed in the stems at the end of the vegetation.



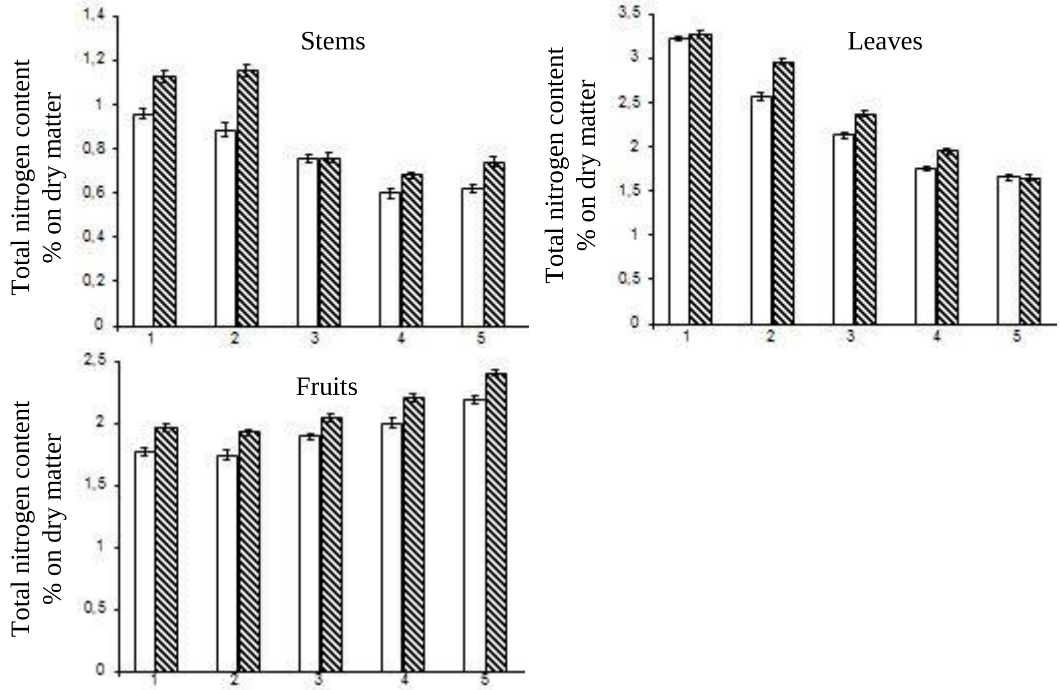
□ – control, ▧ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 18. Influence of chlormequat chloride on the content of total nitrogen in vegetative organs of winter rape

The results of our studies testify that an increase in carbohydrate content in vegetative plant organs of oil flax was accompanied by a decrease in the total content in stems and leaves in both the control experimental variants (Fig. 19).

The maximum amount of nitrogen-containing substances in the leaves and stems was fixed at the initial stages of the study, while the leaves were characterized by a higher content of nitrogen than other organs. The total nitrogen content in the leaves was 2.6-3 times higher than in the stems. By the end of the vegetation, the nitrogen content in the tissues of the vegetative organs decreased more actively under the influence of growth regulators, which, in our opinion, is related to the outflow of nitrogen-containing compounds to the number of fruits that grow.

In the initial stages of vegetation, the total nitrogen content in flowers and fruits was 1,2-1,5 times lower, compared with the leaves, the content of protein nitrogen - 1,4-1,7 times. At the end of the vegetation, during the phases of yellow and full ripeness, the concentration of nitrogen in the boxes in 1,2-1,6 times exceeded the nitrogen content in the leaves. The maximum nitrogen content in the fruit is set at the end of the ripening phase, both in the control and experiment variants.



□ – control, ▧ – chlormequat chloride. Sampling dates: 1-5 – 10-, 20-, 30-, 40-, 50th day after treatment.

Figure 19. Effect of chlormequat chloride on total nitrogen content in vegetative and generative organs of oil flax plants

3. Effect of chlormequat chloride on the productivity and quality of oil crops

The study of the effects associated with the physiological function of phytohormones provided a real opportunity to control the ontogenesis and productivity of plants, the formation of the crop and its quality. This task is realized through the creation and use of synthetic growth and development regulators, which are either analogs of phytohormones or modifiers of their action.

Literary sources contain a large amount of information on the use of phytohormonal preparations in various crops to increase their productivity [27, 31, 42, 43].

In order to optimize productivity, growth regulators of inhibitory type are also used. So as to increase yield, the use of quaternary salts is also used in vegetable [31], technical [42, 53], fruit and berry crops [27].

It is known that the application of plant growth regulators is accompanied by an increase in yields for oil crops. In particular, under the influence of chlormequat chloride in the flax plants, an increase in the seed yield was observed [21].

When rape plants were sprayed with the solutions of Quaternary Onyne Compounds of 3-DEC and 17-DMC, there was an increase in yields by 10-27%, mainly due to the effect on the formation of pods of the main stem [54]. The treatment of soy plants with chlormequat chloride contributed to a more intense accumulation of mass of generative organs and a yield increase of 5-12% [30, 55].

It is admitted that the regulation of donor-acceptor relations in the system of an entire plant is carried out through the coordination of photosynthesis and growth function [31]. This effect can be achieved through morphophysiological changes - the formation of a powerful leaf surface, effective mesostructure, acceleration of the formation of the photosynthetic apparatus and the prolongation of the life of the leaves as the main donor of assimilates [56].

We established that under the influence of chlormequat chloride a more powerful leaf apparatus of poppy, flax, sunflower, and rape plants was formed, the life of the leaves extended, that led to the formation of an excess of assimilates used for the growth of the fruits. The use of the growth inhibitor leads to changes in the crop structure, which is an important basis for increasing the yield of the crops under our investigation (Table 2). The preparation resulted in an increase in the number of pods, an increase in the mass of thousands of seeds and the mass of seeds in a pod in oil poppy plants, an increase in the number of pods, the number of seeds in the fruit and the mass of seeds in the oil flax, growth in the number of achenes in the anthodes, their mass and the diameter of the anthode in sunflower plants.

Table 2. Influence of growth regulator on the productivity of oil crops

Indicators	Control	CCC
Oil poppy		
Number of pods per plant, pcs.	2,5 ± 0,09	*3,1 ± 0,12
Weight of seed in a pod, g	3,0 ± 0,10	*3,5 ± 0,11
Weight of 1000 seeds, g	0,5 ± 0,02	*0,6 ± 0,01
Yield, c / ha	8,4 ± 0,25	*10,1 ± 0,26
Oil flax		
Number of fruits per plant, pcs.	27,00±1,24	*36,94±1,42

Number of seeds in a pod, pcs.	8,25±0,27	*9,23±0,18
Weight of 1000 seeds, g	7,86±0,23	8,16±0,30
Weight of seed from a plant, g	1,75±0,12	*2,75±0,13
Yield, c / ha	18,8±0,6	*21,3±0,5
Sunflower		
Diameter of the anthode, sm	17,4 ± 0,54	*19,2 ± 0,60
Mass af achenes from the anthode, g	59,1 ± 3,60	*69,7 ± 3,55
Number of the achenes in the anthode, pcs.	1101,9 ± 49,64	*1279,0 ± 56,87
Mass of 1000 achenes, g	49,0 ± 1,38	52,8 ± 1,83
Yield, c / ha	26,5 ± 0,71	*30,6 ± 0,51
Winter rape		
Number of pods per plant, pcs.	38,5 ± 1,11	41,3 ± 1,04
Number of seeds ped pod, pcs.	25,1 ± 0,38	25,4 ± 0,07
Weight of 1000 seeds, g	4,3 ± 0,42	4,4 ± 0,11
Yield, c / ha	25,6 ± 0,73	*28,4 ± 0,74

Note: *- the difference is reliable at P≤0.05

We believe that the reason for this phenomenon in the variant with the use of the growth inhibitor chlormequat chloride on poppy and flax plants is the blockage of the synthesis of gibberellins and the partial removal of the effect of apical dominance, resulting in increased stem branching and the formation of more pods, increasing the number of pods, the number of seeds in one pod on a rape plant.

There is evidence in the scientific literature that growth regulators either do not affect the oilseed crops, or lead to a decrease in them [53, 57, 58, 59, 60].

Our studies let us conclude that the use of a plant growth and development inhibitor led to an increase in the oil content of sunflower seeds, flax and rape. However, the application of the retardant resulted in a slight decrease in the oil content in oil poppy seeds (Table 3).

Table 3. Influence of growth regulators on the content and qualitative characteristics of oil poppy, flax, sunflower and rape plants

Variant/ indicator	Acid value (mg KOH per 1 gram of oil)	Saponification value (mg KOH per 1 gram of oil)	Iodine value (g I per 100 gram of oil)	Oil content (% on crude)
Oil poppy				
Control	7,69±0,25	194,62±2,19	127,55±1,49	46,34±0,026
CCC	*6,67±0,25	*205,91±2,53	*134,46±1,13	46,26±0,013
Oil flax				
Control	1,71±0,03	162,50±1,92	153,65±4,62	36,5±0,2
CCC	*1,54±0,07	*170,57±2,42	*168,43±1,47	*39,3±0,2
Sunflower				
Control	2,55 ± 0,087	185,73 ± 3,86	133,86 ± 2,43	52,52 ± 0,20

CCC	2,59 ± 0,070	191,23 ± 2,56	134,96 ± 2,42	*53,29 ± 0,18
Winter rape				
Control	4,40 ± 0,185	193,58 ± 3,02	96,84 ± 1,680	40,10 ± 0,475
CCC	*3,68 ± 0,175	*214,73 ± 2,84	*103,11 ± 1,53	*44,16 ± 0,41

Note: *- the difference is reliable at P≤0.05

The studies conducted by us show the significant influence of the retardant on the qualitative characteristics of the oils under study. In particular, under the influence of an antigibberellin preparation, the number of saponification (the total amount of free and bound fatty acids), iodine number (content of unsaturated fatty acids in the oil) and the number of acidic fatty acids (the index of the content of free fatty acids) increased.

Thus, the quality of oil of poppy seeds of oil crops, oil flax, rape and sunflower treated with chlormequat chloride was higher compared to the control variant.

Our study of the effect of chlormequat chloride on the content of higher fatty acids in investigated oils indicates a considerable effect of the preparation on their profile (Table 4).

Table 4. Influence of growth regulators on the content and qualitative characteristics of oil flax, sunflower and winter rape plants

Indicators	Oil flax		Sunflower		Winter rape	
	Control	CCC	Control	CCC	Control	CCC
C 14	–	–	0,04±0,002	*0,03±0,001	–	–
C16	4,90±0,02	*4,39±0,04	5,51±0,247	5,56±0,235	5,61±0,030	*5,24±0,060
C16:1	0,07±0,01	0,05±0,01	0,07±0,003	*0,05±0,002	–	–
C18	4,19±0,07	*3,57±0,08	3,67±0,169	3,62±0,151	–	–
C 18:1	19,17±0,11	*20,10±0,14	18,97±0,562	17,99±0,538	59,82+0,227	60,34+0,150
C18:2	13,88±0,06	13,91±0,04	71,01±1,094	72,00±1,222	21,42±0,053	*21,91±0,030
C18:3	57,65±0,21	57,88±0,16	0,02±0,001	*0,04±0,001	10,30±0,033	*10,02±0,063
C 20	–	–	0,17±0,007	*0,13±0,006	–	–
C 20:1	0,15±0,01	0,09±0,01	0,10±0,005	*0,05±0,002	1,84±0,010	1,82±0,010
C 22	–	–	0,45±0,025	0,52±0,025	–	–
C 22:1	–	–	–	–	1,01±0,040	*0,68±0,020
The content of unsaturated HFA	90,92±0,31	92,04±0,35	90,17±1,665	90,13±1,765	94,39±0,363	94,77±0,273
The content of saturated HFA	9,09±0,18	7,96±0,14	9,83±0,450	9,86±0,418	5,61±0,030	*5,24±0,060
Unsaturated / saturated HFA	10,00	11,56	9,19	9,14	16,83	18,10

Note: *- the difference is reliable at P≤0.05

In poppy seeds, flax, rape and sunflower seeds, there are myrinisic (C14), palmitic (C16), palmitoleic (C16: 1), stearic (C18), oleinic (C18: 1), linoleic (C18:2), α linolenic (C18:3), arachnoid (C20), gondoin (C20:1), behenic (C22) and erucic (C22: 1) acids, the nutritional value and significance of which are different for the human body and animals.

The results of our studies indicate that the use of growth regulators affects the fatty acid composition of seeds of the studied cultures. Thus, the treatment of plants with chlormequat chloride led to a decrease in the content of saturated acids in oil flax, rape and increased content of saturated acids in sunflower oil.

Taking into consideration the requirements of environmental safety in the application of synthetic plant growth regulator, the study of the content of residual amounts of preparations in finished products is a prerequisite.

The content of residual quantities of growth regulators was determined by chromatography (method of research in the methodical recommendations of scientific and technical documentation - MU № 1909-78) in the Vinnytsia Regional State Laboratory of Veterinary Medicine. According to DSanPin. 8.8.1.2.3.4.-000-2001 the residual amount of chlormequat chloride in the seed should not exceed 0.1 mg kg. In the sample of the seeds of cultivated cultures treated with the retardant, the concentration of the preparation did not exceed the permitted norms.

Conclusion. The use of chlormequat chloride in the budding phase leads to an increase in the productivity of oil poppy, oil flax, winter rape, and sunflower plants, and does not result in the accumulation of residual amounts of the preparation in the seeds above the permitted norms. Under the action of the preparation there is correction of donor-acceptor relations in the investigated plants, which is realized through redistribution of photoassimilates from vegetative growth for the needs of carpogenesis. Deceleration of linear growth at the beginning of vegetation due to the action of chlormequat chloride led to intensive stem branching, formation of a greater number of leaves, leaf surface, optimization of leaf mesostructure and increase of deposited carbohydrates in vegetative organs. The formation of a more powerful acceptor sphere is associated with an increase in the stem branching and, accordingly, the formation of a greater number of fruits - the main acceptors of assimilates in the second half of the vegetation. An increase in the plant's load on the plants in the experimental variant determined also a more intense flow of carbohydrates, nitrogen-containing compounds to them, which eventually ensured the growth of the seed yield.

References

1. Kiriziy, D. A., Stasik, O. O., Prjadkina, G. A., & Shadchina, T. M. (2014). *Fotosintez. T. 2. Assimilyatsiya CO_2 i mehanizmy jejyo regulyatsii*. Logos, Kiev. (in Russian)
2. Bonelli, L. E., Monzon, J. P., Cerrudo, A., Rizzalli, R. H., & Andrade, F. H. (2016). Maize grain yield components and source-sink relationship as affected by the delay in sowing date. *Field Crops Research, 198,* 215-225. doi:10.1016/j.fcr.2016.09.003.
3. Yu, S. M., Lo, S. F., & Ho T. D. (2015). Source-Sink Communication: Regulated by Hormone, Nutrient, and Stress Cross-Signaling. *Trends in Plant Science*, *20*(12), 844-857. doi: 10.1016/j.tplants.2015.10.009
4. Yang, L., Yang, D., Yan, X., Cui, L., Wang, Z., & Yuan H. (2016). The role of gibberellins in improving the resistance of tebuconazole-coated maize seeds to chilling stress by microencapsulation. *Scientific Report*s, *60*, 1-12. doi: 10.1038/srep35447
5. Poprotska, I. V. (2014). Zminy v polisakharydnomu kompleksi klitynnykh stinok simiadolei prorostkiv harbuza za riznoho rivnia donorno-aktseptornykh vidnosyn u protsesi prorostannia [Changes in polysaccharide complex of cell walls of the pumpkin seedlings cotyledons under different level of source-sink relations during germination]. *Fiziologija rastenij i genetika, 46*(3), 190-195 (in Ukrainian).
6. Kuryata, V. G. (2009). Retardanty – modyfikatory gormonalnogo statusu roslyn. Fiziologija roslyn: problemy ta perspektyvy rozvytku. T.1. Logos, Kyiv. (in Ukrainian).
7. Khan M. N., & Mohammad, F. (2013). Effect of GA_3, N and P ameliorate

growth, seed and fibre yield by enhancing photosynthetic capacity and carbonic anhydrase activity of linseed: A Dual Purpose Crop. *Journal of Integrative Agriculture*, *12*(7), 1183-1194. http://doi.org/10.1016/S2095-3119(13)60443-8

8. Rogach, V. V., & Rogach, T. I. (2015). Vplyv syntetychnykh stymuliatoriv rostu na morfofiziolohichni kharakterystyky ta biolohichnu produktyvnist kultury kartopli [Influence of synthetic growth stimulators on morphological and physiological characteristics and biological productivity of potato culture]. *Visnyk of Dnipropetrovsk University. Biology, ecology*, *23*(2), 221-224. doi: https://doi.org/10.15421/011532 (in Ukrainian)
9. Sugiura, D., Sawakami, K., Kojim, M., Sakakibara, H., Terashima, I., & Tateno, M. (2015). Roles of gibberellins and cytokinins in regulation of morphological and physiological traits in Polygonum cuspidatum responding to light and nitrogen availabilities. *Functional Plant Biology*, *42*(4), 397-409. doi: 10.1071/FP14212
10. Kumar, S., Sreenivas, G., Satyanarayana, J., & Guha, A. (2012). Paclobutrazol treatment as a potential strategy for higher seed and oil yield in field-grown *Camelina sativa* L. Crantz. *BMC Research Notes*, *5*:137, 1-13. doi: 10.1186/1756-0500-5-137
11. Yan, Y., Wan, Y., Liu, W., Wang, X., Yong, T., & Yang, W. (2015). Influence of seed treatment with uniconazole powder on soybean growth, photosynthesis, dry matter accumulation after flowering and yield in relay strip intercropping system. *Plant Production Science*, *18*(3), 295-301. http://doi.org/10.1626/pps.18.295
12. de Sousa Lima G. M., Pereira M. C. T., Oliveira, M. B., Nietsche S., Mizobutsi G. P., Filho, W. M. P., Mendes, D. S. (2016). Floral induction management in ‘Palmer’ mango using uniconazole. *Ciência Rural*, *46*(8), 1350-1356. http://dx.doi.org/10.1590/0103-8478cr20150940
13. Kasem, M. M., & Abd El-Baset, M. M. (2015). Studding the Influence of Some Growth Retardants as a Chemical Mower on Ryegrass (*Lolium perenne* L.). *Journal of Plant Sciences*, *3*(5), 255-258. doi: 10.11648/j.jps.20150305.12
14. Altintas, S. (2011). Effects of chlormequat chloride and different rates of

prohexadione-calcium on seedling growth, flowering, fruit development and yield of tomato. *African Journal of Biotechnology*, *10*(75), 17160-17169. doi: 10.5897/AJB11.2706.

15. Carvalho, M. E. A., Castro, C. P. R., Castro, F. M. V., & Mendes, A. C. C. (2016). Are plant growth retardants a strategy to decrease lodging and increase yield of sunflower? *Comunicata Scientiae*, *7*(1), 154-164. doi: https://doi.org/10.14295/cs.v7i1.1286
16. Bárányiová, I., Klem, K. (2016). Effect of application of growth regulators on the physiological and yield parameters of winter wheat under water deficit. *Plant, Soil and Environment*, *62*(3), 114-120. doi: 10.17221/778/2015-PSE
17. Fahad, S., Hussain, S., Saud, S., Hassan, S., Ihsan, Z., Shah, A. N., Wu, C., Yousaf, M., Nasim, W., Alharby, H., Alghabari, F., & Huang, J. (2016). Exogenously Applied Plant Growth Regulators Enhance the Morpho-Physiological Growth and Yield of Rice under High Temperature. *Frontiers in Plant Science*, 7:1250. doi: 10.3389/fpls.2016.01250
18. Pavlista, A. D. (2013). Influence of foliar-applied growth retardants on russet burbank potato tuber production. *American Journal of Potato Research*, *90*(4), 395-401. doi: 10.1007/s12230-013-9307-2
19. Helaly, A. A., Abdelghafar, M. S., Al-Abd, M. T., & Alkharpotly, A. A. (2016). Effect of Soaked *Allium cepa* L. Bulbs in Growth Regulators on their Growth and Seeds Production. *Advances in Plants & Agriculture Research*. *4*(3), 1-7. doi: 10.15406/apar. 2016.04.00139
20. Macedo, W. R., Araujo, D. K., Santos,V. M., Camargo, P. R., & Fernandes, C. G. M. (2017). Plant growth regulators on sweet sorghum: physiological and nutritional value analysis. *Comunicata Scientiae*, *8*(1), 170-175. doi: http://dx.doi.org.vlib.interchange.at/10.14295/CS.v8i1.1315
21. Sang-Kuk, K., & Hak-Yoon, K. (2014). Effects of Gibberellin Biosynthetic Inhibitors on Oil, Secoisolaresonolodiglucoside, Seed Yield and Endogenous Gibberellin Content in Flax. *Korean Journal of Plant Resources*, *27*(3), 229-235. doi: 10.7732/kjpr.2014.27.3.229

22. Rademacher, W. (2016). Chemical regulators of gibberellin status and their application in plant production. In P. Hedden & S.G. Thomas (Eds.) *Annual Plant Reviews*, Volume 49: Gibberellins. (pp. 359-403). John Wiley & Sons, Chichester, U.K. doi: 10.1002/9781119312994.apr0541
23. Matysiak, K., & Kaczmarek, S. (2013). Effect of chlorocholine chloride and triazoles – tebuconazole and flusilazole on winter oilseed rape (*Brassica napus* var. *oleifera* L.) in response to the application term and sowing density. *Journal of Plant Protection Research*, *53*(1), 79-88. doi: 10.2478/jppr-2013-0012
24. Koutroubas, S. D., & Damalas, C. A. (2016). Morpho-physiological responses of sunflower to foliar applications of chlormequat chloride (CCC). *Bioscience Journal*, *32*, (6), 1493-1501. doi: 10.14393/BJ-v32n6a2016-33007
25. Koutroubas, S. D., & Damalas, C. A. (2015). Sunflower response to repeated foliar applications of Paclobutrazol. *Planta daninha*, *33*(1), 129-135. http://dx.doi.org/10.1590/S0100-83582015000100015
26. Kiriziy, D. A. (2004). *Fotosintez i rost rastenij v aspekte donorno-akceptornyh otnoshenij*. Logos, Kiev (in Russian).
27. Kuryata, V. H. (1999). *Fizioloho-biokhimichni mekhanizmy dii retardantiv i etylenprodutsentiv na roslyny yahidnykh kultur*. (Doctoral dissertation). Institute of Plant Physiology and Genetics National Academy of Sciences of Ukraine, Kyiv, Ukraine.
28. Espindula, M. C., Rocha, V. S., Souza, L. T., Souza, M. A., & Grossi, M. A. S. (2010). Effect of growth regulators on wheat stem elongation. *Acta Scientiarum. Agronomy*, *32*(10), 109-113. http://dx.doi.org/10.4025/actasciagron. v32i1.94310.4025/actasciagron.v32i1.943
29. Kuryata, V. G., Negretskyi, V. A., Rogach, V. V., Golunova, L. A., Maznichenko, S. V., & Guliaiev, B. I. (2005). Diia paklobutrazolu na aktyvnist hibereliniv i vmist abstsyzovoi kysloty v lystkakh deiakykh silskohospodarskykh roslyn [Effect of paclobutrazol on gibberellins activity and content of abscisic acid in the leaves of some agricultural plants]. *Fiziologiia i biokhimiia kul'turnykh rastenii, 37*(5), 452.

30. Golunova, L. A., & Kuryata, V. G. (2016). *Rehuliatsiia produktsiinoho protsesu i symbiotychnoi azotfiksatsii soi za dopomohoiu retardantiv* : monohrafiia. TOV «Nilan-LTD», Vinnytsia (in Ukrainian).
31. Tkachuk, O. O., & Kuryata, V. G. (2015). *Diia retardantiv na morfohenez, period spokoiu i produktyvnist kartopli* : monohrafiia. TOV «Nilan-LTD», Vinnytsia (in Ukrainian).
32. Tkachuk, O. O. (2015). Vplyv paklobutrazolu na anatomo-morfolohichni pokaznyky roslyn kartopli [Influence of paclobutrazol on the anatomical and morphological indices of potato plants]. *Naukovyi visnyk Skhidnoievropeiskoho natsionalnoho universytetu imeni Lesi Ukrainky*, *2*, 47-50 (in Ukrainian).
33. Patil, B. N., & Dhomne, M. B. (1997). Influence of plant growth retardants on yield and yield contributing characters in sunflower. *Journal of Maharashtra agricultural universities*, *22*(2), 213-214.
34. Kashid, D. A., Doddamani, M. B., Chetti, M. B., Hiremath, S. M., & Arvindkumar, B. N. (2010). Effect of growth retardants on morpho-physiological traits and yield in sunflower. *Karnataka Journal of Agricultural Sciences*, *23(*2), 347-349.
35. Kuryata, V. G., & Khodanitska, O. O. (2018). Osoblyvosti anatomichnoi budovy i funktsionuvannia lystkovoho aparatu ta produktyvnist roslyn lonu oliinoho za dii khlormekvatkhlorydu [Features of anatomical structure, formation and functioning of leaf apparatus and productivity of linseed under chlormequatchloride treatment]. *Ukrainian Journal of Ecology*, *8*(1), 918-926 (in Ukrainian), doi: 10.15421/2018_294
36. Kuryata, V. G., & Polyvanyi, S. V. (2018). Osoblyvosti funktsionuvannia donorno-aktseptornoi systemy maku oliinoho za dii treptolemu v zviazku z produktyvnistiu kultury [Formation and functioning of source-sink relation system of oil poppy plants under treptolem treatment towards crop productivity]. *Ukrainian Journal of Ecology*, *8*(1), 11-20 (in Ukrainian). doi: 10.15421/2017_182
37. Skubisz G. (1993). Determination of the mechanical properties of winter rape

stalks. *Zeszyty Problemowe Postępów Nauk Rolniczych,* 399, 219-225.

38. Prusakova, L. D., & Chizhova, S. I. (1990). Sinteticheskie reguljatory ontogeneza rastenij. *Itogi nauki i tehniki VINITI. Serija Fiziologija rastenij*. 7, 84-124 (in Russian).

39. Jerdeli, G. S., & Hozhainova, G. N. (1992). *Izobutiraty – novyj klass retardantov*. Izdatel'stvo Voronezhskogo universiteta, Voronezh. (in Russian)

40. Ilumäe, E., Kaarli, K., Hansson, A., & Akk, E. (2005). Folicur EW 250 ja moddus 250 EC toimest suvirapsi kasvule ja saagile. *Transactions of the Estonian Agricultural University*, 220, 180-182 (in Estonian).

41. Kiriziy, D. A., & Guliaiev, B. I. (1994). Ocenka potencial'nyh vozmozhnostej fotosinteticheskogo apparata saharnoj svekly pri iskusstvennoj defoliacii. *Fiziologija i biohimija kul'turnyh rastenij*. *27*(4), 368-373 (in Ukrainian).

42. Shevchuk, O. A., & Kuryata, V. G. (2015). Dija retardantiv na morfogenez, gazoobmin i produktyvnist' cukrovyh burjakiv : monografija. TOV «Nilan-LTD», Vinnycja (in Ukrainian).

43. Kuryata, V. G., & Shevchuk, O. A. (2002). Vplyv retardantiv na rostovi protsesy, morfohenez i produktyvnist roslyn tsukrovoho buriaka. *Scientific Issues Ternopil Volodymyr Hnatiuk National Pedagogical University Series: Biology*. *1*, 46-48 (in Ukrainian).

44. Kuryata, V. G., Golunova, L. A., & Beregovenko, S. K. (2010). Efektyvnist' systemy soja – *Bradyrhizobium japonicum* za dii' paklobutrazolu. *Fiziologija i biohimija kul'turnyh rastenij*. *42*(3), 218-224 (in Ukrainian).

45. Kuryata, V. G., & Golunova, L. A. (2018). Peculiarities of the formation and functioning of soybean-rhizobial complexes and the productivity of soybean culture under the influence of retardant of paclobutrazol. *Ukrainian Journal of Ecology, 8*(3), 98-105 (in Ukrainian).

46. Rogach, V. V., Poprotska, I. V., & Kuryata, V. G. (2016). Diya giberelinu ta retardantiv na morfogenez, fotosyntetychnyj aparat i produktyvnist' kartopli [Effect of gibberellin and retardants on morphogenesis, photosynthetic apparatus and productivity of the potato]. *Visnyk Dnipropetrovs'kogo universytetu. Serija*

Biologija, ekologija. 24(2), 416-419 (in Ukrainian), doi:10.15421/011656

47. Shevchuk, O. A. (2008). Diia retardantiv na nakopychennia ta pererozpodil vuhlevodiv u vehetatyvnykh orhanakh roslyn tsukrovoho buriaka. *Zbirnyk naukovykh prats Vinnytskoho derzhavnoho ahrarnoho universytetu*. *35,* 86-93 (in Ukrainian).
48. Tkachuk, O. O. (2015). Vplyv paklobutrazolu na vmist vuhlevodiv u roslynakh kartopli. *Scientific Issues Ternopil Volodymyr Hnatiuk National Pedagogical University Series: Biology*. *1,* 144-147 (in Ukrainian).
49. Bruns, G., Kuchenbuch, R., & Jung, J. (1990). Influence of a triazole plant growth regulator on root and shoot development and nitrogen utilisation of oilseed rape (*Brassica napus* L.). *Journal of Agronomy and Crop Science, 165*(4), 257-262. https://doi.org/10.1111/j.1439-037X.1990.tb00860.x
50. Kulkarni, S. S., Chetti, M. B., & Uppar, D. S. (1995). Influence of growth retardants on biochemical parameters in sunflower. *Journal of Maharashtra Agricultural Universities, 20*(3), 352-354.
51. Pageau, D., Lajeunesse, J., & Lafond, J. (2006). Effet du taux de semis et de la fertilization azotee sur la productivite du lin oleagineux. *Canadian Journal of Plant Science, 86*(2), 363-370 (in French), https://doi.org/10.4141/P05-078
52. Setia, R. C., Kaur, P., Setia, N., & Anuradha. (1996). Influence of paclobutrazol on growth and development of fruit in *Brassica juncea* (L.) Czern and Coss. *Plant Growth Regulation, 20*(3), 307-316.
53. Sawan, Z. M., & Llorens, E. (2018). Mineral fertilizers and plant growth retardants: Its effects on cottonseed yield; its quality and contents. *Cogent Biology*, 4:1, https://doi.org/10.1080/23312025.2018.1459010
54. Miljuvene, L., Novickene, L., & Gavelene V. (2003). Jeffekt soedinenija 17-DMC na uroven' fitogormonov i rost rapsa *Brassica napus*. *Russian Journal of Plant Physiology*. *50*(5), 733-737 (in Russian).
55. Golunova, L. A. (2015). Diia khlormekvatkhlorydu na produktyvnist ta yakist nasinnia *Glycine max* L. *Scientific Issues Ternopil Volodymyr Hnatiuk National Pedagogical University Series: Biology*. *1,* 66-71 (in Ukrainian).

56. Shadchina, T. M., Guliaiev, B. I., & Kiriziy, D. A. (2006). *Rehuliatsiia fotosyntezu i produktyvnist roslyn: fiziolohichni ta ekolohichni aspekty*. Fitosotsiotsentr, Kyiv (in Ukrainian).
57. Baylis, A. D., & Wright, I. T. J. (1990). The effects of lodging and a paclobutrazol – chlormequat chloride mixture on the yield and quality of oilseed rape. *Annals of Applied Biology*, *116*(2), 287-295.
58. Ullah, F., & Bano, A. (2011). Effect of plant growth regulators on oil yield and biodiesel production of safflower (*Carthamus tinctorius* L.). *Brazilian Journal of Plant Physiology*, *23*(1), 27-31. doi: 10.1590/S1677-04202011000100005
59. Sang-Kuk Kim, Chae-Min Han, Jong-Hee Shin, & Tae-Young Kwon (2018). Effects of paclobutrazol and prohexadione-Ca on seed yield, and content of oils and gibberellin in flax grown in a greenhouse. *The Korean Journal of Crop Science*, *63*(3): 265-271 doi: https://doi.org/10.7740/kjcs.2018.63.3.265
60. Emad EL-Dein A. Ewais, Abd El-Monem M. Sharaf, Esam A. Abd El-Azim, Mohamed A. Ismail, & Mohamed A. Amin. (2013). Effect of ascorbic acid, benzyl adenine and paclobutrazol on growth, yield and some metabolic constituents of sunflower plants. *Al-Azhar Journal of Pharmaceutical Sciences*, 47(1), 12-21. doi: 10.21608/AJPS.2013.7105

Abstract. The influence of retardant chlormequat chloride on the productivity, anatomical and morphological peculiarities as well as functioning of the leaf apparatus of oil crops is studied. The application of the preparation during the budding period led to the enlargement of the number of fruits on plants. The use of the retardant did not cause accumulation of residual amounts of the preparation in the seeds above permitted norms. The application of chlormequat chloride contributed to the increase in the number and leaf mass, the area of the leaf surface of oil poppy plants, oil flax and sunflower plants. At the heart of such changes there was enhanced stem branching under the action of the preparation. The enhancement of the donor function of plants under the influence of chlormequat chloride also occurred as a result of mesostructural changes in the leaves – a more powerful layer of chlorenchyme was formed, linear sizes of chlorenchymal cells increased. Improvement of phytometric and mesostructural parameters of leaves under the action of chlormequat chloride contributed to the enhancement of photosynthetic activity of the leaf apparatus. Under the action of retardant, there was a redistribution of photosynthetic materials from vegetative growth for the needs of carpogenesis, which ensured the growth of yield and quality of products.