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Morphogenesis and the effectiveness of the production process of oil poppy under the complex action of retardant chlormequat chloride and growth stimulant treptolem

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The effect of a combination of chlormequat chloride and growth stimulator treptolem (1:1) on the donor - acceptor relationship, productivity, anatomical, morphological features and functioning of the leaf apparatus of poppy oil plant (*Papaver somniferum* L.) is studied. The treatment of plants by spraying a combination of preparations during the budding period led to an increase in the crop productivity. The redistribution of the flow of assimilates towards the fruit formation occured due to the increase in the number of leaves, the extension of their life, the formation of a larger leaf surface, a more powerful chlorenchyme and the growth of the content of chlorophylls in its cells. The aforementioned led to an increase in the net productivity of photosynthesis and gross photosynthetic productivity of poppy plants and cenosis in general. Such changes resulted in a more intense formation of structural and reserve carbohydrates - sugars and starch, an increase in the extent of its temporary deposit in the roots and leaves of oilseed poppy plants. The application of a complex of preparations also led to the formation of a more powerful acceptor sphere due to the strengthening of stem branching, an increase in the number of fruits (pods) - the main acceptor of assimilates in the fruiting phase. The growth of the oilseed poppy yield under the action of a mixture of chlormequat chloride and treptolem was determined by changes in the crop structure. Simultaneously with the growth of the number of fruits (pods), the mass of seeds in pods and the mass of thousands of seeds increased as well. The use of a combination of preparations did not lead to a violation of toxicological standards - the content of chlormequat chloride and treptolem in the seed did not exceed the permitted norms. The growth of the yield of poppy seed oil due to the action of chlormequat chloride and treptolem was accompanied by an increase in the seed oil content. The quality of poppy oil grew mainly due to an increase in the proportion of unsaturated fatty acids in it. It is also established that the use of a complex of these preparations resulted in accumulation of narcotic alkaloids - tebaina, morphine and codeine in the phase of waxy ripeness in the pods. The obtained solid results can be of interest to the pharmacological industry.
Keywords: Morphogenesis; donor-acceptor system; retardants; treptoleum; productivity; poppy oil (*Papaver somniferum* L.)

Introduction

Application of synthetic growth regulators of different physiological vectors for the purpose of regulation of morphogenesis and optimization of the production process is an important modern branch of phytophysiology. From the standpoint of plant physiology, the change in the growth intensity under the action of physiologically active compounds allows stimulating the different activity of the donor (source) and acceptor (runoff) spheres of any plant, correcting the formation and functioning of these relationships at different stages of ontogeny (Bonelli et al., 2016; Poprotska and Kuryata, 2017; Kuryata et al., 2017). It is already known that the functioning of the donor (photosynthetic tissues and organs) and acceptor (growth zone, deposition of substances in the reserve and active metabolism zones) of the spheres in the plant is interconnected in such a way that the rate of growth determines the photosynthetic activity of the donor sphere (Kiriziy et al., 2014 ; Yu et al., 2015; Bonelli et al., 2016). The knowledge of the ways and mechanisms of the functioning and regulation of the activity of the donor-acceptor system, especially by artificially redistributing assimilates to economically important organs (fruits, root crops, and other reserve organs) under the influence of phytohormones and various classes of synthetic growth regulators, opens up new possibilities to optimise plant productivity, to clarify the physiological mechanisms through which the distribution of flows of assimilates between plant organs occurs (Yan et al., 2013; Yan et al., 2015; Wang et al., 2016).

Amongst exogenous growth regulators of plants there is the most widely used group of synthetic inhibitors of growth processes - retardants. The mechanism of the physiological action of the representatives of this group consists in the fact that they are antigibberellins - blocking the synthesis or physiological effect of already synthesized gibberellin in a plant (Kuryata, 2009; Sang-Kuk and Hak-Yoon 2014; Rademacher, 2016). The study and analysis of available scientific data testifies to the fact that the usage of growth inhibitors induces an artificial change in morphogenesis (Altintas, 2011; Yang, et al., 2016, Rogach et

al., 2016;), regulates the activity of the growth function (Espindulà, 2010; Kasem and Abd El-Baset, 2015; Carvalho et al., 2016), photosynthetic activity per unit leaf area and the whole plant and the cenosis as a whole (Kumar et al., 2012; Kuryata and Kravets, 2018). It also affects the processes of carpogenesis, plant load with fruits and seeds (Zhang et al., 1997; Kasem and Abd El-Baset, 2015; It also affects the processes of carpogenesis, plant load with fruits and seeds (Zhang et al., 1997; Kasem and Abd El-Baset, 2015; Carvalho et al., 2016; Koutroubas and Damalas, 2016), to increase plant resistance to adverse environmental factors (Li et al., 2010; Peng et al., 2014; Fahad et al., 2016), to regulate product quality (Souza et al., 2016; Panyapruek et al., 2016).

Amongst various groups of retardants, chlormequat chloride is most frequently used, since it does not detect carcinogenic and blastomogeneous properties, accumulate and decompose in the body; after 48 hours it is removed from it. The aforementioned factors determine its extensive application in plant cultivation. We found out that the data on the influence of this and other retardants on morphogenesis and oilseed crop productivity are little and contradictory (Kumar et al., 2012; Matysiak and Kaczmarek, 2013; Koutroubas and Damalas, 2015, 2016). However, vegetable oils are one of the important constituents of the human diet. The production of vegetable fats has a number of advantages over animal fats. These should include a relatively low cost price, such as waste production, greater utility for health, which is associated with the optimal profile of fatty acids and the content of fat-soluble vitamins. In this connection, new technological techniques for the production of oilseeds are being developed in order to increase their productivity. In particular, for the optimization of the production process of oilseed poppy, a highly effective technique was the use of retardant chlormequat chloride during the budding period (Kuryata and Polyvanyi, 2018 b).

However, the use of a new synthetic growth stimulator of treptolem plants, which is a complex of N-oxide of 2,6-dimethylpyridine with amber acid, Emistim C, as well as amino acids, carbohydrates and trace elements, was effective on oilseeds. The preparation is recommended for application in oilseeds - sunflower, winter and spring rape plant and showed high efficiency in the culture of oil poppy (Kuryata and Polyvanyi, 2018 a). Since the separate use of chlormequat chloride and treptolemum was sufficiently effective to increase the productivity of oil poppy seed, it would be advisable, in our opinion, to establish a possible positive complex action of the preparations on the productivity of the crop.

Increasing the scope of production and the use of synthetic growth regulators increases the risk of pollution of the environment and agricultural products. In this regard, the use of such preparations should be determined by severe toxicological and hygienic requirements. They should not accumulate in plants, in the soil and affect its microflora. There is a need for such regulations for the use of preparations that would allow the maximum effect with minimal doses of retardant. The study of physiological and biochemical mechanisms of action of various groups of retardants is a prerequisite for determining the ways to increase the efficiency and safety of the application of this group of growth regulators in oilseeds.

In this regard, the purpose of this study is to find out the complex effect of retardant chlormequat chloride and growth stimulator treptolem on morphogenesis, peculiarities of the formation and functioning of donor - acceptor relationships in oil poppy seed plants due to the crop yield.

Research methods

Oil poppy seed plants of cv.Berkut were treated with a combination of (1:1) 0.5% chlormequat chloride and treptolem at a concentration of 0.035 ml/l in the budding phase with the help of a sprayer OP-2, control plants sprayed with tap water. The research was conducted in the conditions of Vinnytsia region in 2012-2014. The land plots were placed at random, the size of the plots is 10 m^2, and the repetition is five fold.

Chlormequat chloride (CCC, α-chloroethyltrimethylammonium chloride) - $[Cl\text{-}CH_2\text{-}CH_2N\text{-}(CH_3)_3]^+ Cl^-$ is a white crystalline substance decomposed at a temperature of 245 °C, insoluble in hydrocarbons, but soluble in water: its solubility is 74% at 200C. LD50 for white rats is 640 mg/kg, the maximum daily dose for a human is 0.07-0.09 mg. The maximum level of the preparation in food is 0.1 - 0.3 mg/kg. The preparation is low-toxic, its antibiotic effect is associated with inhibition of the activity of ents-kauren-synthase in the formation of copanyl pyrophosphate from geranilgrananoyldifosfate in the process of synthesis of gibberellins.

Treptolem is a composite preparation, which is a combination of synthetic (N-oxide 2,6-dimethylpyridine complex with amber acid - 50 g/l) and natural growth regulators of auxin, cytokinin nature (Emistim C - 1.0 g/l), as well as amino acids, carbohydrates and minor constituents. The preparation is recommended for the use in oilseeds - sunflower, winter and spring rape plant.

The recording of the samples for analysis was carried out by liquid nitrogen in the field, then in the laboratory conditions they were dried at a temperature of 85 °C. in a drying cabinet. The properties of the leaf mesostructure of the control and experimental variants were studied at the end of the vegetation period on the leaves, whose growth process was finished. The material for anatomical research was preserved in a combination consisting of equal parts of ethyl alcohol, water and glycerol and 1% of formaldehyde. The sizes of individual leaf tissues were determined under a microscope on transverse sections with the help of an ocular micrometer. The errors in measurements of the cellular size of the columnar and spongy chlorenchyma were carried out in the tissue matracates of the leaf. As a maceration agent, 5% solution of CH_3COOH in 2 M HCl was used. Quantitative contents of chlorophyll (a+c) were determined on a spectrophotometer SF-16, starch and sugars-using the iodometry (AOAC, 2010). Foliar leaf index (LI) was estimated on the total area of the calcareous surface of poppy plants per 1 m^2 of agrocenosis area. The net productivity of photosynthesis is the increase in the mass of dry matter per day per unit area of the leaf surface. The content of crude oil was determined by extraction of poppy seeds in the Soxhlet apparatus using petroleum ether. Quantitative gas chromatography of the resulting oil on the contents of individual fatty acids was carried out on a chromatograph «Crystal-2000» (Russia). The conditions of chromatography are described in our

previous paper (Kuryata and Polyvanyi, 2018). The content of alkaloids was also defined by gas chromatography (Davydyuk et al., 2009).
The content of chlormequat chloride residues in oil poppy seeds was fixed by chromatography in a thin layer of cationite on chromatographic plates «Silufol UV-254» (the Czech Republic). Chromatograms were detected in a 11% solution of phosphoric-molybdic acid, washed for 30 minutes with water, immersed in a 1% solution of $PbCl_2$ in 10% HCl. The content of chlormequat chloride was calculated from the optical density of the specimen at a wavelength of 730 nm on a spectrophotometer SF-46 (Russia). Investigation of the residual amount of treptolem was performed by high-performance liquid chromatography on the chromatograph «Crystal 2000M» of the company SCB «Chromatek» (Yoshkar-Ola, Russia). Steel 100 mm columns, filled with 5% sorbent SE-30 were used. Gas flow rate was 60 ml/min., The gas carrier was nitrogen. The temperature of the column was 240 °C, the evaporator temperature was 260 °C, the temperature of the flame-ionization detector – 300 °C. Separation of residual quantities of treptolem from oilseed poppy seeds was carried out in accordance with GOST 13496. 20-87.
Recurrence of analytical research is fivefold. The tables and charts present the average data for three years of research. Processing of statistical data was carried out using the STATISTICA-6 computer program StatSoft Inc. The reliability of the difference between control and experiment variants was determined by the Student's t-test.

Results

The mechanisms of action of retardant chlormequat chloride and exogenous growth stimulant of treptolemum are known to differ. Retardant is a preparation with an antigibberellin action mechanism, it limits the synthesis and implementation of the action of gibberellins (Kuryata, 2009), and the use of treptolemum enhances growth processes due to the fact that they contain phytohormones of auxin and cytokinin action (Kuryata and Polyvanyi, 2018 a). Since, as chlormequat chloride and treptolem often lead to increased productivity of crops, it was advisable, in our opinion, to analyze the effect of the complex of these preparations on the plant's growth function.
One of the key approaches in optimizing the production process of agricultural plants is the regulation of donor and acceptor relationships, in particular by artificially redistributing flows of assimilates to economically important organs (fruits, root crops).
Such an effect can be achieved through morphophysiological changes-the formation of a mighty leaf surface, dexterous mesostructure, acceleration of the formation of the photosynthetic apparatus and the prolongation of the leaf life as the principal donor of assimilates. With sufficient power of the assimilation apparatus, artificial inhibition of the growth of vegetative organs leads to the redistribution of assimilates to the needs of fruit formation.
It is established that the application of a combination of retardant and growth stimulator did not cause a decrease in plant height but led to an increase in the linear size (length and thickness) of the stem and the formation of a more powerful leaf apparatus (Figure 1).
The treatment of oil poppy sowings with the combination of these preparations resulted in an increase in the number, total area and dry weight of leaves. Such changes in plants of experimental variants are caused by an increase in the number of shoots of the second order -3.1 ± 0.11** compared with the control variant, where their number is 2.49 ± 0.09 (the difference is reliable at P <0.001). At the time of morphometric measurements during the period of milk ripeness, these indices in the experimental variant were larger in comparison with the control ones and in comparison with the separate use of treptolem and chlormequat chloride (Figure 1).

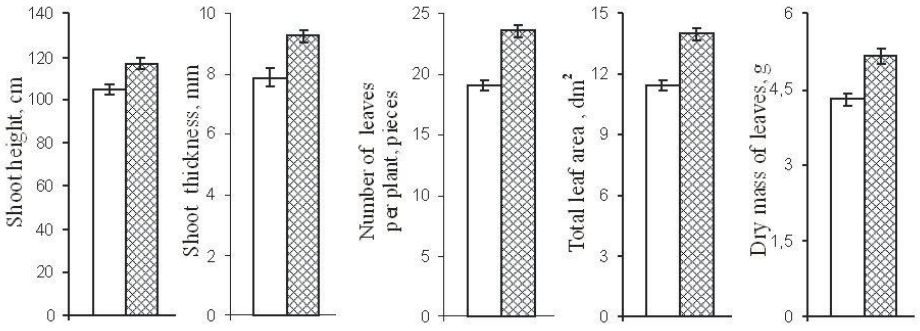

Figure 1. Morphometric indices of oil poppy plant under the action of a combination of chlormequat chloride and treptolem: ☐ - control, ⊠ - a combination of treptolem (0.035 ml/l) and 0.5% chlormequat chloride.

This testifies to the formation of a more powerful donor potential of the photosynthetic apparatus in plants of the experimental variant. The use of a mixture of preparations also led to stem thickening, which increased the resistance of the poppy to the inclining and provi ded technological advantages in harvesting.
One of the considerable indicators of the plant production process of is the leaf index, which is defined as the ratio of the area of the leaf surface to the planting area. We have found that the use of a mixture of preparations brought about an increase in this cenotic index compared with the control variant (Table 1), which is one of the prerequisites for the growth of poppy production. However, the plant yield depends not only on the area of the leaf surface, but to a large extent on the

features of the internal structure of the leaf, which in the scientific literature is called «mesostructure». The obtained results demonstrate the effect of the mixture of preparations that caused a significant increase in the proportion of the specific mass of leaves, which characterizes the mass unit of leaf area. The importance of this indicator is defined by the fact that it characterizes the concentration of elements of leaf structure, which are related to the implementation of photosynthesis. The analysis of the results testifies to the growth of the photosynthetic activity of the unit of leaf area - the index of net productivity of photosynthesis (NPP net photosynthetic productivity) under the action of the mixture of preparations.

The analysis of the mesostructural arrangement of poppy leaves treated with a mixture of preparations shows a considerable enlargement of leaf thickness owing to the growth of assimilation parenchyma (chlorenchyma) - the key photosynthetic leaf tissue. Thickening of the collenchyma occurred due to a better development of its cells, the linear dimensions of which under the action of the mixture of preparations increased in comparison with the control sample. The enlargement of the particle size of chlorenchyme in the leaf structure is an important factor affecting the content of pigments and photosynthetic processes. The results provide evidence for a significant increase in the sum of chlorophyll content in the leaf (Table 1).

Table 1. The effect of a complex of preparations on the functioning of the leaf apparatus of oil poppy plants (M ± m, n=20).

Indicators	**Control**	**A complex of preparations**
Leaf index m^2/m^2	4.16 ± 0.12	5.75 ± 0.15**
Weight of leaf area g/dm^2	0.31 ± 0.013	0.263 ± 0.011*
Net productivity of photosynthesis $g/(m^2 \times day)$	0.48 ± 0.016	1.05 ± 0.032***
Leaf thickness, microns	234.1 ± 5.73	290.2 ± 5.49***
Thickness of the assimilation parenchyma, microns	126.9 ± 2.88	178.31 ± 2.37***
The length of chlorenchyma cells, microns	44.2 ± 0.89	56.5 ± 1.13***
Width of chlorenchyma cells, microns	23.1 ± 0.91	36.4 ± 0.76***
Sum of chlorophylls (a+c),%	0.23 ± 0.002	0.27 ± 0.003***

Notes: 1*- the difference is significant at P < 0,05, **- P < 0,01, ***- P < 0,001; 2 A complex of preparations - Treptolem (0.035 ml/l) + CCC (05%).

Given the increase in the number and area of leaves in the experimental variants, the increase in the content of chlorophylls, optimizing the mesostructure and increasing the photosynthetic productivity of leaf area unit (pure photosynthesis productivity), it can be stated that under the influence of a mixture of preparations the optimal conditions for optimization of the production process of poppy seed oil plants are created.

Consequently, the effects of the chlormequat chloride and treptolemic complex form a more powerful donor sphere than in the control variant and a separate use of preparations (Kuryata and Polyvanyi, 2018 a and b). Such anatomical-morphological and physiological changes of the donor-acceptor system result in an enhanced formation of nonstructural carbohydrates and their accumulation in the leaves and roots of poppy plants (Figure 2). Attention is drawn to the fact that throughout the ontogenesis the content of nonstructural carbohydrates in the roots was quite high. In our opinion, this indicates the significant depositional possibilities of this vegetative body.

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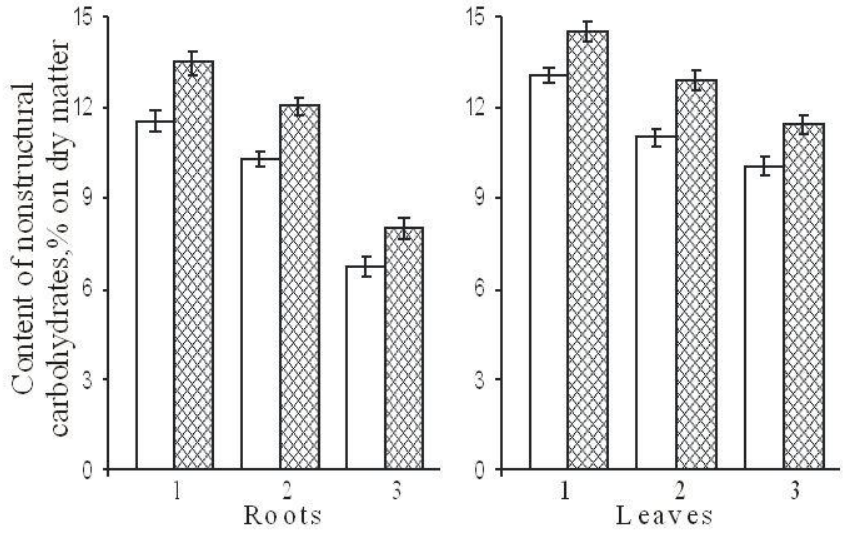

Figure 2. Changes in the content of non-structural carbohydrates in the leaves and roots of oil poppy seed under the action of a combination of growth regulators: ☐ – control, ▨ – a combination of treptolem (0.035 ml/l) and 0.5%-th chlormequat chloride. Sampling time: 1, 2, 3 - 10, 20, 30th day after treatment.

The application of growth regulators leads to the formation of excess carbohydrate content in leaves compared to the control variant. The excess of sugars in the vegetative organs of treated plants creates a reserve of assimilates, which is used for the needs of carpogenesis (Figure 3). Based on current data on the nature and mechanisms of action of chlormequat chloride and treptolem, it can be asserted that the use of these preparations in combination allows simulating an increase in the auxin+cytokinin/gibberellin proportion. Such changes in the balance of physiologically active substances and the functioning of the system of source of assimilates - the drain led to a more active flow of plastic substances in the direction of generative organs-pods, which predetermined the growth of yield of culture. Thus, under the action of a combination of preparations this figure was 10.1 ± 0.26** (c/ha) relative to 8.4 ± 0.25 (c/ha), in the variant without treatment.

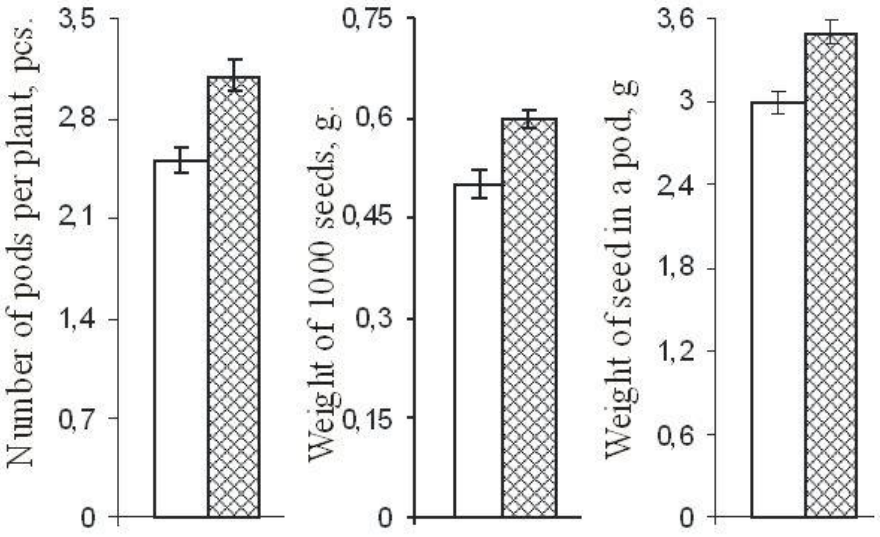

Figure 3. Influence of a combinations of preparations on the structure of oil poppy plants: ☐ - Control, ▨ – A combination of treptolem (0.035 ml/l) and 0.5% - th chlormequat chloride.

The effect of a mixture of preparations was manifested in changes in the crop structure. Thus, in conditions of a small-field experiment, at the same time as the number of pods, a mass of thousands of seeds and a mass of seeds in a box increased (Figure 3).

Treatment of poppy plants with a mixture of preparations resulted in an increase in the content of oil in poppy seeds 47.45 ± 0.021*** compared with the control variant 46.31 ± 0.032 (the difference is reliable at $P<0.001$). The nutritional value of poppy oil is largely determined by the profile of fatty acids. The presence of palmitic, palmitoleic, stearic, oleic, linoleic, α-linolenic, peanut and gondoic acids is established in Berkut oil poppy seed, the nutritional value and significance of which are different for the human body and animals (Table 2).

Table 2. Effect of a mixture of drugs on the content of higher fatty acids (HFA) in poppy oil(%, n=5).

Indicators	Control	A complex of preparations
C16	7.91 ± 0.037	7.49 ± 0.035***
C16:1	0.09 ± 0.003	0.11 ± 0.003**
C18	1.76 ± 0.015	1.65 ± 0.028*
C 18:1	18.15 ± 0.027	18.21 ± 0.041
C18:2	71.26 ± 0.213	71.71 ± 0.205
C18:3	0.62 ± 0.012	0.63 ± 0.013
C20	0.16 ± 0.003	0.14 ± 0.004*
C20:1	0.05 ± 0.001	0.06 ± 0.001***
Unsaturated HFA	90.17 ± 0.285	90.72 ± 0.263
Saturated HFA	9.83 ± 0.051	9.28 ± 0.061***
The correlation of unsaturated / saturated HFA	9.17 ± 0.18	9.78 ± 0.23

Note: See Table 1.

The analysis of the proportion between unsaturated and saturated fatty acids demonstrates that the treatment of plants with a mixture of preparations contributed greatly to an increase in the content of unsaturated fatty acids in the oil, which is evidence of improving its nutritional value.

An important issue in topography is to monitor the content of alkaloids in the raw material. Narcotic alkaloids (morphine, codeine, tebain) are known to be found in opium in small quantities, and the content of other alkaloids does not exceed 0.1%. In studying the content of alkaloids in poppies, we found that the use of a mixture of preparations largely influenced their content: in the pods of the experimental variant, at the end of the vegetation period, the content of alkaloids was higher than in the control variant (Figure 4).

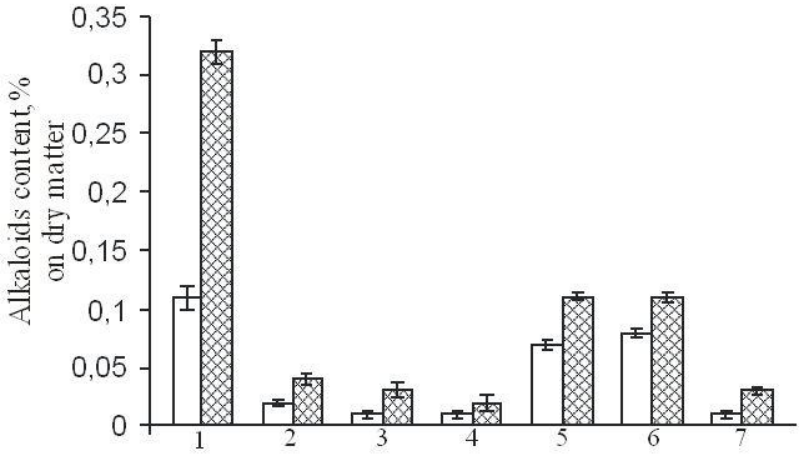

Figure 4. Change in the content of alkaloids in oilseed poppy plants under the action of a combination of preparations: ☐ – control, ▨ – a combination of treptolem (0.035 ml/l) and 0.5%-th chlormequat chloride. The list of alkaloids: 1-morphine, 2-codeine, 3-tebaine, 4-neopin, 5-papaverine, 6-narcotine, 7-Orapavin.

It is established that the preparations increased the content of narcotic alkaloids-morphine, codeine and tebaine. In the poppy pods in the phase of waxy maturation, the presence of non-narcotic alkaloids: neopin, papaverine, narcotine, oriparin was established, the content of which in all variants of the experiment was identified in an unknown number. The obtained results can be of interest to the pharmacological industry.

Taking into account the requirements of environmental safety in the application of synthetic plant growth regulators, a necessary condition is the study of the content of residual quantities of preparations in products.

We also found that in experimental samples of seed of treated plants, the poppy seed oil content of chlormequat chloride was 0.0013 mg/kg, and the residual amount of treptoleum was 0.005 mg/kg. According to the State Sanitary Rules and Regulations (8.8.1.2.3.4.-000-2001), the residual amount of CCC must not exceed 0.1 mg/kg, and the residual amount of treptolem must not exceed 0.03 mg/kg, that is, the product corresponds to the sanitary norms.

Discussion

The use of analogues and phytohormones and modifiers of their effects allows simulating different levels of tension between the donor and acceptor spheres of the plant, which makes it possible to find out the role of morphological, mesostructural and physiological components in the functioning of this system. The obtained experimental results confirm that the usage of a complex of chlormequat chloride and treptolem causes changes in anatomic-morphological and cenotic parameters. The application of a mixture of preparations contributed to the formation of a more powerful donor field of the plant-there was

an increase in the number and weight of leaves, the area of the leaf surface of the plant itself, the life of the leaves lasted, as well as an important coenotic index-a leaf index. The reason for such morpho-physiological changes was increased stem branching under the action of a complex of preparations. In oil poppy plants, treated with the complex, a more powerful layer of photosynthetic tissue-chlorenchyma - was formed. Thickening of the layer of this tissue occurred because of the better development of its cells, the linear dimensions of which increased in comparison with the control variant under the action of the complex of preparations The enlargement of the particle size of chlorenchyme in the leaf structure is a meaningful factor affecting the content of pigments and photosynthetic processes. The result of such mesostructural changes was the growth of the index of pure productivity of photosynthesis. Under the action of the mixture of preparations there was a more intense accumulation of non-structural carbohydrates (sugars+starch) in the leaves, as well as in the roots of oil poppy plants. Therefore, the growth of the leaf area surface in combination with the growth of the index of photosynthetic activity per unit area added to the growth of the gross formation of plastic substances both by as a single plant and by cenosis as a whole. The usage of a complex of chlormequat chloride and treptolem resulted in the formation of a more powerful donor sphere of oil poppy seed and boosted its activity. The main acceptor of assimilates during the fruiting phase is the processes of fruit formation and growth. Under the influence of a complex of chlormequat chloride and treptolem, a large number of flowers and fruits were deposited in pods; as a result, an acceptor capacity of this part of the plant grew. Such changes in the balance of the functioning of the system source of assimilates (donor)-drain (acceptor) led to a more active inflow of plastic substances to the generative organs - pods, which caused the growth of the yield of the culture. The effect of the mixture of preparations was manifested in the changes in the structure of the crop - at the same time as the number of pods grew the mass of thousands of seeds and the mass of seeds in the box grew as well. The action of the mixture of preparations increased the content of oil in poppy seeds. The presence of palmitic, palmitoleic, stearic, oleic, linoleic, α-linolenic, arachinic and gondoic acids was established in Berkut oil poppy seed plants. The analysis of the ratio between unsaturated and saturated higher fatty acids indicates that the treatment of plants with a mixture of treptolem and chlormequat chloride contributed to an increase in the content of unsaturated fatty acids in the oil, which is evidence of an improvement of its nutritional value. The results of the research indicate that the influence of preparations in pods increased the content of narcotic alkaloids - morphine, codeine and tebain. In poppy pods in the phase of waxy maturation the presence of non-narcotic alkaloids: neopin, papaverine, narcotic, oripavin was established; their content in all variants of the experiment was insignificant. These results may be interesting for the pharmacological industry. The obtained results indicate that the use of the mixture of retardant chlormequat chloride and the growth stimulator treptolem did not lead to the accumulation of residues of preparations above the permitted norms.

Conclusion

The general conclusions of this research paper rest on the fact that treatment of oilseed poppy plants during the budding period with a mixture (1:1) of retardanthlormequat chloride and a growth stimulator of treptolem resulted in increased crop yield. The redistribution of assimilate flows towards the formation of fruits is due to the growth of the number of leaves, the formation of a larger leaf surface, a more powerful chlorenchyme and the growth of the content of chlorophylls in its cells. The aforementioned led to an increase in the net productivity of photosynthesis and gross photosynthetic productivity of poppy plants and cenosis in general. Such changes resulted in a more intense formation of structural and reserve carbohydrates - sugars and starch. The use of a complex of preparations also caused the formation of a more powerful acceptor sphere due to the strengthening of stem branching, an increase in the number of fruits (pods)-the main acceptor of assimilates in the fruiting phase. The growth of the yield of oil poppy seed under the action of chlormequat chloride and treptolem was accompanied by an increase in the seed oil content. The quality of poppy oil grew owing to an increase in the proportion of unsaturated fatty acids in it.

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