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Photosynthetic activity of sunflower under the effect of a plant growth regulator in the steppe zone of Ukraine

The process of converting the energy of solar radiation into the energy of chemical bonds of organic compounds is called photosynthesis. It represents a complex of photophysical, photochemical and enzymatic reactions that take place in a clear order.

A well-developed photosynthetic apparatus is the basis for obtaining high sunflower yield. With the help of solar energy, it accumulates organic substances from inorganic compounds. The main organ of plants that synthesizes the energy of the sun is leaves. The accumulation of vegetative mass depends not only on the size of the leaf surface, but also on the duration of the interstage period. Therefore, the photosynthetic process occurs differently in different stages of crop development. It is known that the higher the rate of energy utilization for photosynthesis is, the higher amount of dry matter is formed and the less energy is spent on water transpiration. A well-developed photosynthetic apparatus, which has an optimal volume and dynamics of functioning, is one of the factors for obtaining sustainable yields.

The efficiency of plant photosynthesis is determined by a large number of factors, therefore it is very important to develop measures aimed at promoting sufficiently fast rates of development of the optimal leaf area and its long-term functioning.

During 2017-2019, in the conditions of Melitopol district of Zaporizhzhia region, we conducted experiments on the high-oleic 'Colombi' sunflower hybrid using different methods of applying the AKM+Ca plant growth regulator.

Experimental design included four variants: 1. Control (without treatment with a plant growth regulator); 2. Pre-sowing treatment of the seeds by AKM+Ca; 3. Spraying of the plants in the inflorescence emergence stage by AKM+Ca; 4. Pre-sowing seed treatment by AKM+Ca + Spraying of the plants in the inflorescence emergence stage (BBCH 50-51) by AKM+Ca. The dose of AKM plant growth regulator was applied according to the List of pesticides and agrochemicals approved for use in Ukraine. Each variant of the experiment had four replications, with systematic plot placement.

Determination of the net productivity of photosynthesis, dry mass were carried out according to generally accepted methods. The obtained data was processed statistically.

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Starting from the first stages of crop vegetation, a direct relationship was observed between the biomass accumulation of 'Colombi' sunflower plants and the pre-sowing treatment with AKM+Ca. It was established that the lowest intensity of accumulation of dry matter during the studied period was observed in the control variant. However, the use of

AKM+Ca for pre-sowing treatment of sunflower seeds contributes to the growth of this indicator by 5.1 - 25.2 %, depending on the development stage.

It should be noted that the variant with the double application of plant growth regulator AKM+Ca for pre-sowing seed treatment and spraying of plants in the inflorescence emergence stage had the greatest effect on the accumulation of dry matter by sunflower plants, where the increase in this indicator in the flowering phase (BBCH 63-65) was 8.5 % higher than the control.

Table 1

Dynamics of dry matter accumulation by the plants of ‘Colombi’ sunflower hybrid when plant growth regulator is applied, g/m²

Plant growth regulator	BBCH development stage				
	12-14	18-20	39-41	50-51	63-65
Control (no application)	26.9	45.3	154.7	245.6	752.3
Spraying the plants with AKM+Ca	-	-	-	-	763.8
Pre-sowing seed treatment with AKM+Ca	29.3	56.7	180.7	270.7	790.7
Pre-sowing seed treatment with AKM+Ca + Spraying the plants with AKM+Ca	-	-	-	-	816.0
LSD ₀₅	2.5	3.1	10.1	3.0	5.6

For a more complete assessment of the photosynthetic activity of sunflower plants, we used the net photosynthetic productivity index (NPP), which determines the amount of dry matter produced during photosynthesis by 1 m² of leaves per 1 day (Table 2).

Table 2

Net photosynthetic productivity of the plants of ‘Colombi’ sunflower hybrid when plant growth regulator is applied, г/м² за добу

Plant growth regulator	BBCH development stage				
	12-14	18-20	39-41	50-51	63-65
Control (no application)	0.77	3.99	3.34	8.66	0.77
Spraying the plants with AKM+Ca	-	-	-	-	0.83
Pre-sowing seed treatment with AKM+Ca	0.90	4.19	3.82	9.16	0.85
Pre-sowing seed treatment with AKM+Ca + Spraying the plants with AKM+Ca	-	-	-	-	0.90
LSD ₀₅	0.07	0.11	0.24	0.60	0.03

As a result of the research, it was determined that the net photosynthetic productivity of the ‘Colombi’ hybrid fluctuated within certain limits depending on the application method. Pre-sowing treatment of sunflower seeds contributed to a more intensive work of the photosynthetic apparatus, where the NPP index was higher than in the control by 5.0 to 16.9% (depending on the development stage). In the variant with dual use of AKM+Ca for pre-sowing seed treatment and for spraying of the plants in the inflorescence emergence stage, this index in the flowering stage (BBCH 63-65) had 5.9 - 16.9% higher values compared to all variants of the experiment. This allows control of the photosynthetic activity of sunflower crop and allows to expect higher yields with better quality indicators.

Therefore, in order to improve the photosynthetic activity of the plants of ‘Colombi’ sunflower hybrid in the arid conditions of the Southern Steppe zone of Ukraine, it is advisable to carry out pre-sowing seed incrustation with AKM+Ca plant growth regulator, especially in combination with spraying plants in the inflorescence emergence stage.