

INFLUENCE OF ULTRADISPERSE IRON AND COPPER POWDERS ON THE OIL CONTENT OF COTTON SEEDS AND ON THE FATTY ACID COMPOSITION OF THE SEED LIPIDS

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The oil contents and the fatty acid compositions of the lipids of cotton seeds of varieties AN-402 and AN-9 grown under the influence of ultradisperse powders (UDPs) of iron and copper have been studied. Changes in the absolute weight, oil content, and fatty acid composition of the seeds have been shown. The action of an iron UDP led to an appreciable fall in the amount of palmitic acid in the AN-402 variety and a rise in the oleic acid content.

Highly disperse and ultradisperse powders (UDPs) of metals as a new class of biologically active compounds have been studied mainly on animals [1, 2]. UDPs of iron and copper raise the crop yields of cotton and some other agricultural plants [3]. In this paper we give the results of investigations of the influence of UDPs of iron and copper on the oil content of cotton seeds and on the fatty acid composition of their total lipids.

The presowing treatment of seeds of cotton plants of varieties AN-402 and AN-9 with suspensions of UDPs of iron and copper at a concentration of 2 mg per liter exerted an action not only on the crop yields but also on the oil contents and other characteristics of the seeds (Table 1). At the same time, different reactivities of these cotton plant varieties to the action of the metal UDPs were found. Under the influence of the iron UDP the weight of seeds from variety AN-402 remained at the level of the control while the amount of kernels decreased by 0.68% and the oil content of the seeds by 0.5%.

Under the action of the copper UDP, the weight of seeds and the oil content of the kernels fell, while the oil content of the seeds remained at the level of the control. Thus, it has been established that, at the given concentration, a copper UDP causes a slight fall in oil content.

As compared with the presowing treatment of the seeds, the treatment of the plants through the leaves by spraying with a 2 mg/liter suspension of the iron UDP showed an appreciable stimulating effect. As can be seen from Table 1, such a treatment of a cotton plant raised the absolute weight of the seeds and increased the amount of kernels by almost 2%, the amount of oil in the kernels by 1.5%, and the amount in the seeds by 1.0% as compared with the control. This is possibly connected with an enhancement of photosynthetic processes, since iron participates in the biosynthesis of chlorophyll and enters into the enzyme composition of the electron-transport chain.

A cotton plant of the AN-9 variety differed from the AN-402 variety with respect to its reactivity to an iron UDP. On the presowing treatment of seeds of variety AN-9 with a suspension of the iron UDP, their absolute weight remained at the level of the control and the oil contents of the kernels and of the seeds decreased, while the amount of kernels increased (Table 1). This can apparently be explained by an enhancement of the synthesis of seed proteins. In contrast to AN-402, the variety AN-9 proved to be more sensitive to the action of a copper UDP. In this case, the absolute weight of the seeds increased by more than 1% and the amount of kernels by 2.76% as compared with the control. With respect to the oil content of the kernels and seeds under the action of the copper UDP, the experimental plants were inferior to the control.

The fatty acid compositions of all the lipids were determined by gas-liquid chromatography [6, 7] (Table 2). The fatty acid compositions of all the lipids of the seeds of AN-402 cotton plant grown from seed after presowing treatment with suspension of the iron UDP differed from those of the lipids from the seeds of control groups of plants: the level of the C_{18:1}

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TABLE 1. Action of Ultradisperse Powders of Iron and Copper on Cotton Seeds

Variety and variant	Weight of 100 seeds, g	Yield of kernels, %	Oil content, %	
			in the kernels	in the seeds
AN-402				
Control	10.19	52.81	39.9	21.6
Fe UDP	10.26	52.13	40.0	21.1
Cu UDP	9.47	52.27	39.6	20.7
Fe UDP (through the leaves)	12.0	54.83	41.4	22.6
AN-9				
Control	9.8	51.43	42.2	21.7
Fe UDP	9.8	51.6	39.9	20.7
Cu UDP	10.9	54.29	39.7	21.0

TABLE 2. Action of Iron and Copper UDPs on the Fatty Acid Compositions of the Total Lipids of Cotton Seeds

Variety and variant	Fatty acid, %					
	C _{14:0}	C _{16:0}	C _{16:1}	C _{18:0}	C _{18:1}	C _{18:2}
AN-402						
Control	0.6	26.8	1.1	1.9	19.9	49.7
Fe UDP	0.7	22.8	1.1	2.3	22.4	50.7
Cu UDP	0.7	26.7	0.9	2.2	20.5	49.0
Fe UDP (through the leaves)	0.6	24.6	1.1	2.1	22.2	49.4
AN-9						
Control	0.6	26.0	1.0	1.9	19.3	51.2
Fe UDP	0.6	26.9	0.7	1.9	20.2	49.7
Cu UDP	0.6	23.9	0.9	1.9	20.3	52.4

acid had increased by 2.5%, that of the C_{18:2} acid by 1%, and that of the total unsaturated fatty acids by 3.52%. It must be mentioned that under the action of the iron UDP the C_{16:0} content of the seeds fell by 4%. Although some indices of the fatty acid compositions of the control and experimental samples differed by the magnitude of the experimental error, numerous experiments confirmed the tendency that we had observed.

The action of the copper UDP on the fatty acid compositions of the total lipids of the AN-402 seeds was similar to the action of the iron UDP but less pronounced (see Table 2). Under the action of the copper UDP the total amount of saturated and unsaturated fatty acids remained at the level of the control.

The action of the iron UDP through the leaves on the fatty acid composition of the seed lipids of variety AN-402 was more appreciable: the level of palmitic acid fell by 2.2% while that of oleic acid increased by 2.3% and that of linoleic acid remained at the level of the control.

On comparing the action of the iron UDP on the fatty acid compositions of the cotton plant varieties studied, it can be seen that the totals of the saturated and unsaturated fatty acids differed by 3.6%.

Thus, it has been shown that the action of iron and copper UDPs leads to changes in the oil content of the seeds of the cotton plant varieties investigated and in the fatty acid composition of the oil. Under the action of an iron UDP, the quality of the seed oils of both varieties improves as the result of increases in their oleic acid contents.

EXPERIMENTAL

The iron and copper UDPs were obtained from the OF Institute, Russian Academy of Sciences. Suspensions of the iron and copper UDPs were prepared by sonication in an aqueous medium with the aid of a UDZN-2T disperser at a power of 22 kW for 5 min, followed by dilution to a concentration of 2 mg per liter. The cotton seeds were steeped in the resulting suspension for 16 h and were sown in experimental plots of Andizhan State University. The oil contents of the cotton seeds of the crop obtained were determined by Rushkovskii's method in a Soxhlet apparatus [4, 5], using diethyl ether, b.p. 36°C, as solvent. Fatty acid compositions were determined by Vereshchagin's method [6] on a LKhM-8 instrument with a highly sensitive thermal conductivity detector: column 2 m long; internal diameter, 3 mm; solid phase, Porolit 80 mesh; liquid phase, Silar 10%; thermostat temperature, 203°C; evaporator temperature, 270°C; rate of flow of carrier gas (helium), 65 ml/min; instrumental error not greater than 1.2%.

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