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THE EFFECT OF TABEX AND LACTOFOL ON SOME PHYSIOLOGICAL CHARACTERISTICS OF ORIENTAL TOBACCO

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Summary. The effect of monoethyl adipinic acid ester (MEEAdA – tabex) and of the leaf suspension fertilizer lactrofol on some physiological characteristics of oriental tobacco was studied in relation with mineral nutrition. It was found that treatment with tabex, lactofol and their combination of plants grown on the available soil supply with unbalanced nutrients (unfertilized) increased chlorophyll *a* and *b* contents in the leaves of oriental tobacco, the size of the leaves, their intensity of photosynthesis and biological productivity. Treatment of plants on balanced nutrition with the indicated substances had no positive effect on the characteristics studied and their values were close to the respective control.

Key words: retardants, mineral nutrition, plastid pigments

Introduction

Besides plant stimulators, retardants of plant growth are often applied in practical work. These retardants are growth regulators for a great number of physiological processes in plant organisms (Kado et al., 1971; Pandey, 1973). Alar (N,N-dimethylhydrasid of succinic acid) is such a kind of retardant. It belongs to the group of retardants inhibiting gibberellic transport and is widely applied in the regulation of flowering and fruit ripening, in increasing plant resistance to unfavourable conditions, etc. (Wittwer, 1971; Hurter et al., 1988). The monoethyl ester of adipinic acid (MEEAdA – tabex), is a structural analogue of alar and its application blocks temporarily the metabolic processes, important for tobacco plant growth (Karanov, 1979; Karanov and Alexieva, 1985; Alexieva and Karanov, 1987; Petkova et al., 1992, 1994). The use of appropriate retardants for the delay in growth of tobacco seedlings is suitable in cases when unfavourable climatic conditions should be avaded, at times when transplanting is impossible.

Mineral fertilizers applied to the soil generally ensure the needs of the plants for macroelements, but microelements are not always sufficient and in a form easy to be accepted by the plants. In some stages of their development cultivated plants have particularly great need of nutrient substances – usually these are the phases of fast growth, accumulation of vegetative mass and development of reproductive organs. Leaf fertilizer application to the plants in such cases of their development leads to higher biological productiveness (Pavlova et al., 1992; Ivanov, 1992).

The suspension fertilizer lactofol applied by the authors is a biological product in which the microelements are bound in complexes of lactic acid (lactate).

The aim of the present investigation was to study the effect of tabex and lactofol on some physiological characteristics of oriental tobacco in relation with mineral fertilizer nutrition.

Material and Methods

Oriental tobacco of the cultivar Krumovgrad 58 was used as the object of investigation. A part of the tobacco plant seedlings at the phase 3-4 leaves were treated with 2% water solution of tabex (monoethyl ester of adipinic acid). Ten days post this treatment plants equal in size were planted in vegetation Wagner pots filled with 8 kg of air dry alluvial meadow soil. At the time of transplanting the plants were divided into two experimental groups. The plants of the first group were grown on the available soil supply N – 4.06 mg/100 g soil, K_2O – 18 mg/100 g soil, P_2O_5 – 4.9 mg/100 g soil (unfertilized).

The group included 4 variants: 1 – Control, not treated plants; 2 – Tabex treated plants; 3 – Lactofol treated plants; 4 – Plants treated with combined tabex and lactofol.

In the second experimental group the plants were also divided in the same 4 variants, but to the soil were added N – 5 mg/100 g of soil, P_2O_5 – 2.1 mg/100 g of soil and K_2O – 1.8 mg/100 g of soil, so that an optimal ratio among the macroelements could be fixed in accordance with the requirements of oriental tobacco determined after the systematic variants of Homes (Pandev et al., unpublished data, 1992).

All variants were in 15 replications with two plants. Definite groups of plants at the phases 4th and 11th developed leaf were treated with 1% solution of the leaf suspension fertilizer lactofol. Samples for the determination of the plastid pigments were taken from the 5th, 12th, and 20th fully developed leaves. The determination was made spectrophotometrically on 80% acetone extraction after Arnon. Photosynthesis was measured on the 5th and 12th fully developed leaf with the system of photosynthetic measurements Li-6000 (Li-Cor., USA). Dry matter was assessed after the weight method.

Least significant differences in the yield were found using Student's criterion.

Table 1. Plastid pigments content in 5th leaf (in mg/g fresh weight)

Variants	Chlorophyll *a*	% of the control	Chlorophyll *b*	% of the control	Carotenoids	% of the control
			unfertilized			
1. Control	0.414	100.0	0.125	100.0	0.146	100.0
2. Tabex	0.489	118.1	0.139	111.2	0.148	101.4
3. Lactophol	0.507	122.5	0.154	123.2	0.139	95.2
4. Tabex + Lactophol	0.549	132.6	0.165	132.0	0.151	103.4
			fertilized			
5. Control	0.654	100.0	0.190	100.0	0.177	100.0
6. Tabex	0.592	90.5	0.172	90.5	0.174	98.3
7. Lactophol	0.669	102.3	0.194	102.1	0.194	109.6
8. Tabex + Lactophol	0.639	97.7	0.194	102.1	0.163	92.0

Results and Discussion

Results corcerning the contents of chlorophyll *a* and *b* and of the carotenoids at the phase of 5th developed leaf are presented in Table 1. In the variants of the first experimental group, as compared to the respective control, chlorophyll *a* was increased by 18.1% and chlorophyll *b* – by 11.2% after treatment with tabex, and respectively by 22.5% and 23.2% after treatment with lactofol. This stimulating effect had highest expression in the combined treatment. The increase was 32.6% for chlorophyll *a* and 32% for chlorophyll *b*. The percentage of carotenoid content differed within a small range.

The plastid pigment content of the same leaves in the 2nd experimental group did not change significantly after the respective treatments. Tabex treatment reduced chlorophyll *a* and *b* by 9.5%, while plants treated with lactofol and with the combination had a content of chlorophyll close to that in the control. On the whole the chlorophyll content of the leaves from that group was higher than that in the respective variants of the first experimental group.

In samples taken at the later period (development of the 12th leaf), the positive effect of the treatment with the respective substances on the first experimental group (unfertilized) and the negative effect in the second (fertilized) had a considerably higher expression (Table 2). In tabex treated plants from the first experimental group chlorophyll *a* increased 45%, while *b* – 51.7%, as compared to the respective control. In lactofol treated plants this increase was 20.3% and 32.7%, respectively. The increase was greatest after combined treatment.

Table 2. Plastid pigments content in 12th leaf (in mg/g fresh weight)

Variants	Chlorophyll *a*	% of the control	Chlorophyll *b*	% of the control	Carotenoids	% of the control
			unfertilized			
1. Control	0.202	100.0	0.058	100.0	0.099	100.0
2. Tabex	0.293	145.1	0.088	151.7	0.116	117.1
3. Lactophol	0.243	120.3	0.077	132.8	0.107	108.1
4. Tabex + Lactophol	0.347	171.8	0.107	184.5	0.117	118.2
			fertilized			
5. Control	0.538	100.0	0.169	100.0	0.154	100.0
6. Tabex	0.353	65.6	0.107	63.3	0.110	71.4
7. Lactophol	0.421	78.3	0.134	79.3	0.144	93.5
8. Tabex + Lactophol	0.329	61.2	0.107	63.3	0.113	73.4

Carotenoid content increased from 8% to 18%. At the same time in plants of the second group the content of chlorophyll *a* was reduced 34.4% and chlorophyll *b* – 34.7% after tabex treatment, and 21.8% and 20.7% after lactofol treatment as compared to the respective control. Combined treatment led also to reduced chlorophyll in the leaves. Carotenoids were reduced considerably less than chlorophylls. The opposite trend was observed in plants with 20th developed leaf of the first experimental group (Table 3). In the tabex treated plants the content of chlorophyll *a* was slightly

Table 3. Plastid pigments content in 20th leaf (in mg/g fresh weight)

Variants	Chlorophyll *a*	% of the control	Chlorophyll *b*	% of the control	Carotenoids	% of the control
			unfertilized			
1. Control	0.267	100.0	0.088	100.0	0.115	100.0
2. Tabex	0.243	91.0	0.084	95.5	0.103	89.6
3. Lactophol	0.204	76.4	0.084	95.5	0.083	72.2
4. Tabex + Lactophol	0.210	78.7	0.071	80.7	0.088	76.5
			fertilized			
5. Control	0.283	100.0	0.092	100.0	0.110	100.0
6. Tabex	0.158	55.8	0.055	59.8	0.062	56.4
7. Lactophol	0.352	124.4	0.112	121.7	0.145	131.8
8. Tabex + Lactophol	0.233	82.3	0.079	85.9	0.093	84.5

reduced by 9% and that of chlorophyll *b* – by 4.6%, while in the lactofol treated plants – by 23.6% and 4.6%. Combined treatment reduced chlorophyll *a* by 21.4% and chlorophyll *b* by 19.3% as compared to the respective control. Tabex reduced the carotenoids by 10.4%, lactofol by 21.8% and the combined treatment – by 23.5%. In the second experimental group the inhibiting effect of tabex was most obvious. Its reduction of chlorophyll *a* was 44.2% and of chlorophyll *b* – 40.2%. The combined treatment decreased their content significantly less. Only in lactofol treated plants the chlorophylls increased 21.7% and 24.4% respectively, while the carotenoids – 11.8%. This fact was due probably to the last lactofol treatment of the plants by which added nutrient substances were provided to the plants. The loss of stimulating effect observed for tabex in respect to chlorophyll biosynthesis at the later phases was due most probably, on the one side, to the considerably long period from treatment to taking the samples determining chlorophyll content and, on the other, to ageing of the plants.

Treatment of the plants with tabex, lactofol and their combination affected also leaf size. Data presented in Fig. 1 show that the measurement values for the length and width of 7th and 14th leaf of plants on unbalanced nutrition (first experimental group) are higher than those of the respective control. The seventh leaf of tabex treated plants was 5.78 cm longer and 4.12 cm wider than the same leaf on control plants. For lactofol treated plants these data were 1.81 cm and 0.09 cm higher and for the combined treatment – 5.83 cm and 3.47 cm higher. In plants on balanced nutrition the values for length and width of the 7th leaf were close to those of the control. The same trend was observed in the sizes recorded for the 14th leaf. The positive effect of treatment with the named substances on leaf size in plants from the first experimental group was also preserved in the later phases (development of the 21st leaf). This leaf in tabex treated plants was 3.35 cm longer and 2.53 cm wider than the respected untreated control, while in the plants treated with the combination these values were 2.45 cm and 1.97 cm higher.

A slight increase of leaf size in the middle and upper plant parts was also found after treatment of oriental tobacco with lactofol by other authors (Ivanov, 1992).

In the latest periods of taking samples (28th developed leaf) no stimulating effect of the treatment was observed on leaf growth in the first experimental group and their size was lower than the respective untreated control. In plants of the second experimental group which had received nutrient substances in accordance with their requirements (variants 5, 6, 7 and 8) the treatment did not have a significant influence on leaf growth and they were similar in size to the respective control or even smaller. This fact showed that the treatment had a positive effect on the growth of leaves in case the plants had not received the nutrient substances necessary for their optimal development (variants 1, 2, 3 and 4) and tabex probably stimulated the absorption of nutrient elements from the soil. The positive effect of lactofol on the growth of leaves and plants from the first experimental group was due to the added fertilizer application with the leaf suspension fertilizer lactofol.

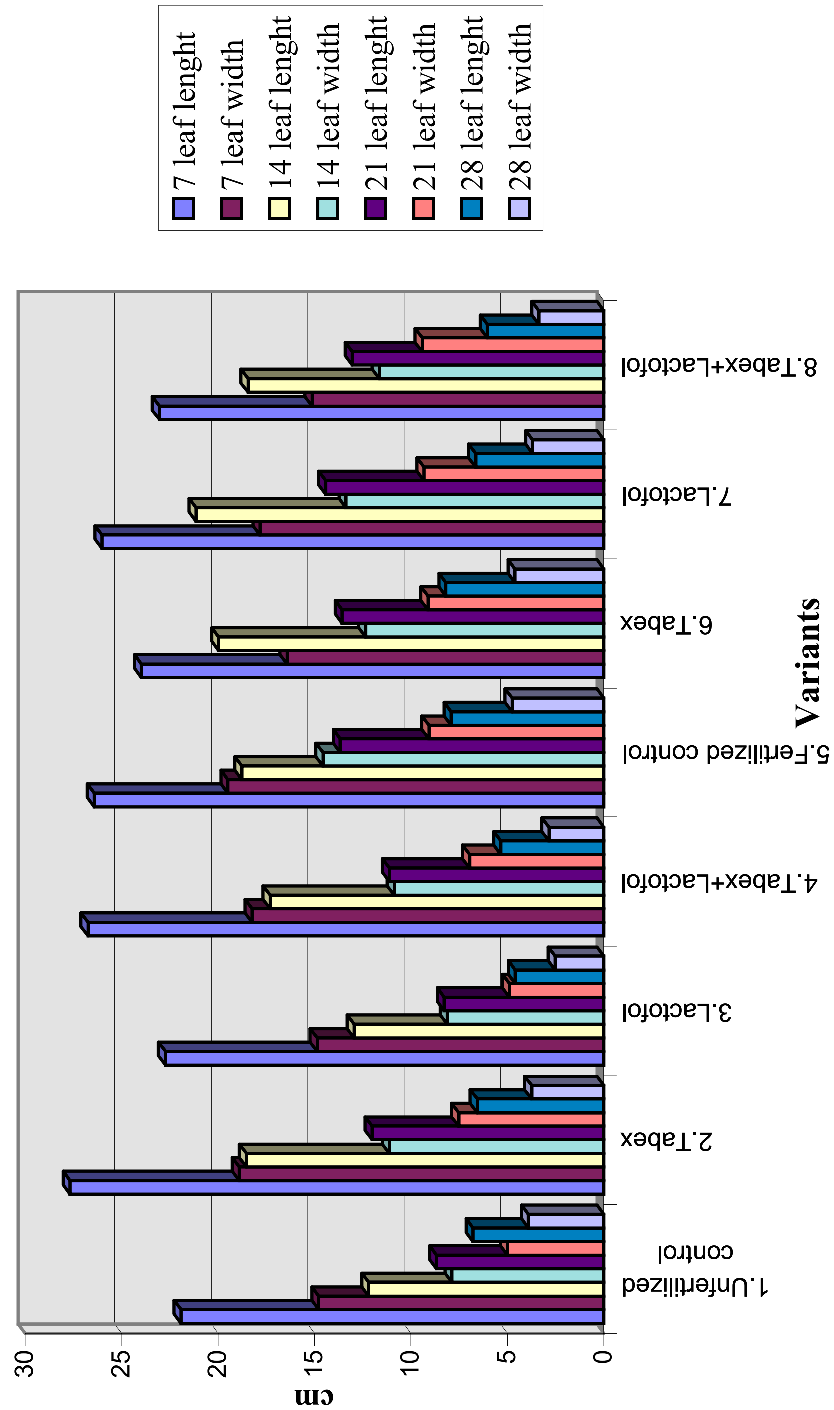

Fig.1. Biometric parameters in leaves

Table 4. Intensity of photosynthesis in 5th and 12th leaf

Variants	5th leaf		12th leaf	
	mg CO_2 $m^{-2}.s^{-1}$	% of the control	mg CO_2 $m^{-2}.s^{-1}$	% of the control
		unfertilized		
1. Control	0.625	100	0.221	100
2. Tabex	0.769	123	0.318	145
3. Lactophol	0.765	122	0.197	90
4. Tabex + Lactophol	0.738	118	0.281	127
		fertilized		
5. Control	0.570	100	0.370	100
6. Tabex	0.543	95	0.272	72
7. Lactophol	0.533	94	0.339	92
8. Tabex + Lactophol	0.698	122	0.373	100

Data concerning the measured rate of net photosynthesis in the fully developed 5th leaf proved that a positive effect of the treatment was observed in plants of the first experimental group (Table 4). Single treatment with tabex and the combined treatment with tabex + lactofol enhanced the rate of photosynthesis from 18% to 23% in respect to the respective control. In plants of the second experimental group only the combined treatment increased photosynthethic rate with 22%, while the single treatment slightly reduced it. A similar trend was also observed in the fully developed 12th leaf. The effect of single and combined treatment with tabex and lactofol in plants of the first experimental group was most expressed in the treatment with tabex and its combination with lactofol – 145% and 127%, respectively.

Treatment of plants with balanced nourishment with the indicated substances had not a positive effect on the intensity of photosynthesis and its absolute values were lower, close to or as those of the respective control.

The economically useful part of oriental tobacco are its leaves, therefore of greatest importance is the effect of plant treatment with tabex and lactofol on the quantity of the accumulated biomass. Treatment of plants with unbalanced nourishment (first experimental group) led to a considerable increase of dry matter, both at the individual harvests and in the total biomass of the leaves (Table 5). Highest increase of the biological productivity was produced by combined treatment of the plants with tabex + lactofol – 60% more than the respective control. Single treatments with tabex and lactofol enhanced the biomass with 41.9% and 22.6%. Plants with optimal nutrition and treatment accumulated leaf dry matter almost equal to their own control.

These results substantiate the general conclusion that treatment of plants on unbalanced nutrition (unfertilized) with tabex, lactofol and their combination has a

Table 5. Accumulated dry weight in leaves at harvesting and total (in g per plant)

Variants	Harvesting 1st	2nd	3rd	4th	5th	6th	7th	Total	% of the control
				unfertilized					
1. Control	0.81	2.66	1.90	2.31	1.66	1.64	1.42	12.40	100.0
2. Tabex	0.89	2.76	2.88	4.30	3.14	2.56	1.07	17.60	141.9
3. Lactophol	1.38	3.23	2.38	3.04	2.50	1.91	0.76	15.20	122.6
4. Tabex + Lactophol	1.13	3.52	3.14	5.21	3.48	2.61	0.75	19.84	160.0
				fertilized					
5. Control	1.06	3.96	3.26	4.58	3.20	3.98	1.26	21.30	100.0
6. Tabex	1.00	3.42	2.51	3.94	3.28	4.42	1.64	20.20	94.8
7. Lactophol	1.04	3.83	2.90	4.86	3.71	4.08	1.00	21.42	100.6
8. Tabex + Lactophol	0.96	5.01	2.41	4.00	3.34	3.57	1.08	20.37	95.6

$P < 0.05$–0.783
$P < 0.01$–1.031
$P < 0.001$–1.378

positive effect on chlorophyll biosynthesis and increases the contents of chlorophyll *a* and *b* in the leaves of oriental tobacco, their size, the intensity of photosynthesis and their biological productiveness as compared to the respective unfertilized control. Treatment of plants with balanced fertilizers with the indicated substances had no positive effect on the investigated characteristics and their values were close to their respective controls.

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