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PHOTOSYNTHETIC PIGMENTS IN WHEAT PLANTS AS INFLUENCED BY TWO DIFFERENT TYPES OF SALINITY

BY

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ABSTRACT

Different concentrations of NaCl and Na_2SO_4 (0.1, 0.2, 0.3, and 0.4%) induced an increase in Chl a and Chl b in the 4-and 8-day old wheat seedlings (Triticum aestivum cv. Sakha 69). Carotenoids and total pigments were increased with all Na_2SO_4 levels and with 0.1 and 0.2% NaCl. Chl a contributes relatively more than other two pigment fraction in total pigments. The a/T ratio exceeded 50% in different Na_2SO_4 concentrations and was higher with Na_2SO_4 than with NaCl.

INTRODUCTION

The pigment contents which could be regarded as a criterion for photosynthetic activities [1,2] were found not only to depend on plant genotypes but also on environmental and nutritional conditions surrounding it [3]. In this respect, Dostanova [4] found that leaves of salinized sugar beet plants had more chlorophylls and carotenoids compared with those grown under non-saline conditions. Also, El- Deeb [5] found that pigments were markedly

activated in salinized maize, whereas a reduction occurred in safflower plants.

However, Carter and Myers [6] and Ashour and Thalooth [7] working with sugar beet, Shimose [8] with rice, Heikal [9] with sunflower, Shaybany and Kashirad [10] with Acacia saligna, and Ahmed et al. [11] with maize, reported a general decrease in photosynthetic pigments with salinity.

It is assumed in the present study to find out the response of the developing seedlings of wheat (Triticum aestivum cv. Sakha 69) regarding the main photosynthetic pigments under the influence of NaCl and Na_2SO_4 types of salinity.

MATERIALS AND METHODS

Wheat grains were germinated on moist Whatman filter paper, 12 cm diameter. The grains were soaked in appropriate salt concentration (0.1 - 0.4 % NaCl or Na_2SO_4). Seedlings were harvested after 4, 8 and 12 days for the extraction of pigments. The temperature of the green house, where seeds were incubated, ranged between 24 - 27°C at day time and between 22 - 23°C at night.

In each age of seedling, fresh samples were ground immediately in a mortar, then extracted with 85% cold

acetone in the dark to prevent photooxidation of Chl a. The extract was left for 24 hours in refrigerator to be sure of complete extraction of pigments, then centrifuged to get rid of cell fragments. No dilution was made before measurement. The colour intensity was measured at 663, 644, and 452 nm [12] . The following equations were applied for the calculation of the pigment constituents (in ug / ml) of seedling leaves :

$$\text{Chlorophyll a (Chl a)} = 10.3\ E_{663} - 0.918\ E_{644}$$

$$\text{Chlorophyll b (Chl b)} = 19.7\ E_{644} - 3.87\ E_{663}$$

$$\text{Carotenoids (Carot)} = 4.2\ E_{452} - (0.0264\ \text{Chl a} + 0.426\ \text{Chl b})$$

Pigment fractions were calculated as ug/g dry weight.

Statistical Analysis

Data were computed statistically to find out any significant difference in each pigment fraction among ages and concentrations. For this purpose, the two-way analysis of variance (Anova-2) was applied according to Steel and Torrie [13].

RESULTS

Chl a, Chl b, Carot and total pigments tend to

increase with development in the control (Fig. 1). Different levels of Na_2SO_4 caused a marked increase in the photosynthetic pigments in the 4- and 8- day old seedlings. This was pronounced in the 0.3% treated seedlings. In addition a marked increase in each pigment fraction and total pigments took place with 0.2% NaCl in 4- and 12-day old seedlings. However, such increase was detected only in Chl a, Chl b and total pigments with 0.3% NaCl in 8-day old seedlings.

Chl a, Carot, and total pigments tended to increase in 4-day and 8-day old seedlings treated with Na_2SO_4 until 0.3% concentration. On the other hand, Chl a, Chl b, and total pigments tended to decrease in 12-day old seedlings with Na_2SO_4.

Regarding NaCl, Chl a/total pigments (a/T), Chl a + Chl b/total pigments (a+b/T) and Chl a/Chl b (a/b) ratios tended to increase from the 4-day until 12-day old seedlings grown under 0.1% and 0.2% NaCl besides the control (Table 1,2, and 3). Moreover, the a/T ratio for 0.1, 0.2, and 0.3%, a+b/T ratio for 0.1, 0.3, and 0.4% and a/b ratio for 0.2 and 0.3% Na_2SO_4 tended to increase with age. Statistical analysis indicated that effects of age, Na_2SO_4 concentrations and their interaction were significant at 1% level on Chl a, Chl b, and carotenoids.

For NaCl, significant differences were obtained with Chl a and Carot, while no difference with age and concentration were shown for Chl b.

DISCUSSION

The most abundant pigments (chlorophylls), the carotenoids and phycobilins actively participate photochemical reactions. NaCl salinization was reported to increase pigment production of more tolerant species, especially at moderate levels. In this regard, Haroun [14] observed that pigment content in Pisum sativum plants was increased on dry weight basis at low salinity levels, while decreased with increase in NaCl. In the present study, total pigments, Chl a, Chl b, and Carot were found to increase in 4- and 12-day old wheat seedlings with 0.2% NaCl. Results obtianed indicate that Chl a contributes relatively more than the two other fractions in total pigment content. In this respect, Strogonov et al. [15] showed that increase in chlorophyll content in more tolerant plants was due to either Chl a or Chl b accumulation. Kasim [16] found that a pronounced increase in photosynthetic pigments was obtained in Hordeum vulgare with 0.1 M NaCl in cv. Giza 119 and with 0.05 M NaCl in cv. Sahrawy and concluded that increase in total pigments was mainly due to Chl a. Photosynthetic pigments were found to increase in kidney bean plants in culture solutions of NaCl up to 90 meq for 14 days [17].

Changes in pigment content were reported to be affected by the interaction between osmotic potential of the applied solution and that of seedlings under stress. In this respect, Ahmad [18] detected disintegration in chlorophyll at high salinity levels (50 meq NaCl/liter).

Results indicated that levels obtained on 4-day and 8-day old wheat seedlings for Chl a, Chl b, Carot and total pigments were higher than the control in all Na_2SO_4 concentrations, and for Chl a, Chl b and total pigments in those of NaCl (Fig. 1). In most NaCl levels Chl a exceeded 50% of the total pigment content in 8-day and 12-day old seedlings (Table 1). The ratio a/T for NaCl was, in most cases lower than that of Na_2SO_4.However, a/T and a+b/T ratios increased with age (Table 1,2). Hayward and Wadleigh [19] reported that the sulphate rescricts the absorption of calcium while promoting the uptake of sodium. Jenning [20] indicated that smaller changes in osmotic potential of leaf sap with increasing of sulphate levels compared with chloride may be due to slower permeation of sulphate ion. In this study wheat seedlings were found to respond to sulphate in a way different than that of chloride regarding carotenoids. This could be referred to suggestion reported by Jenning.

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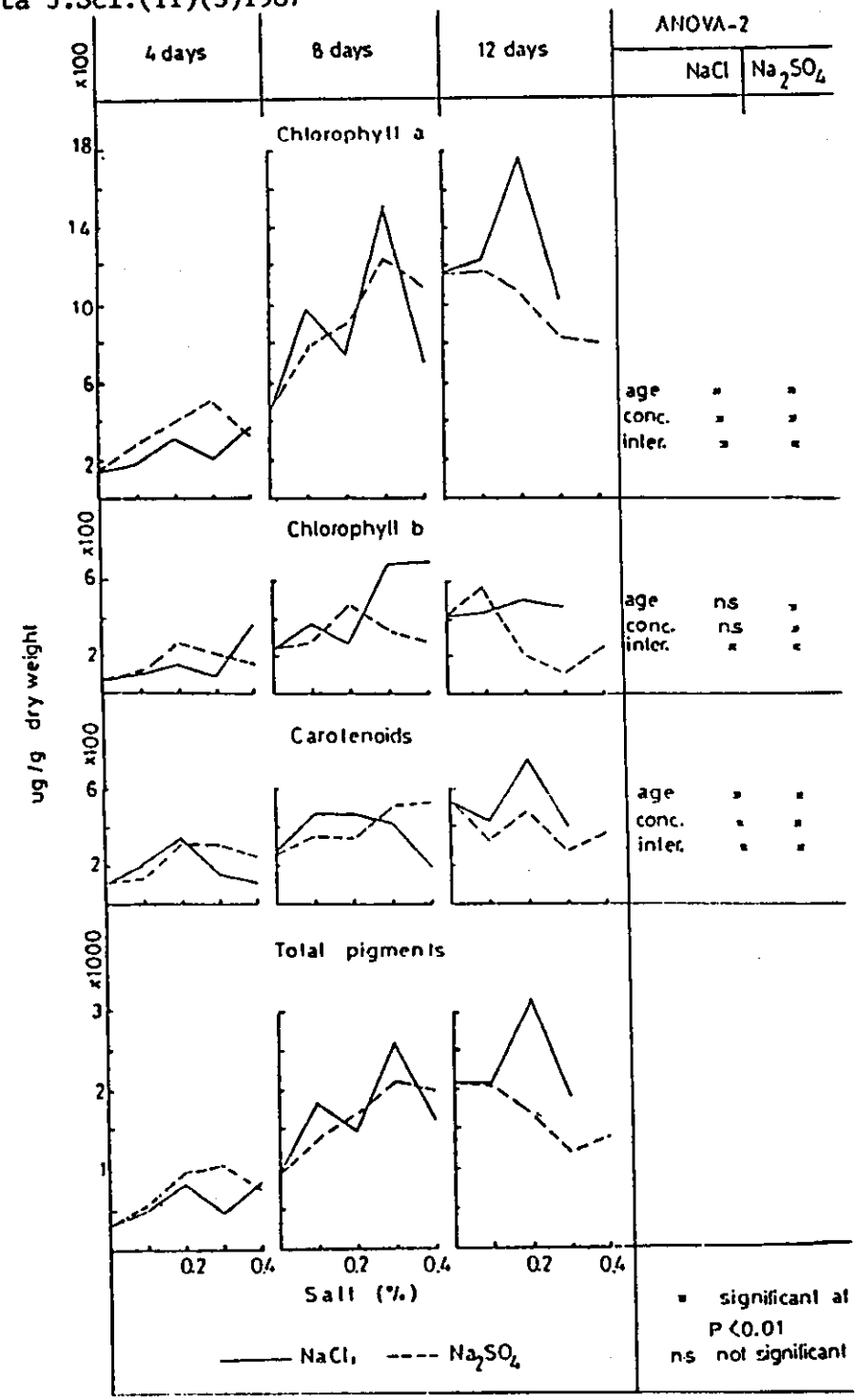

Fig.1 · Pigment concentrations of wheat seedling leaves treated with $NaCl_2$ or $NaSo_4$

Table 1 : a/T ratios of wheat seedlings treated with NaCl or Na_2SO_4

Age (Day)	NaCl (%)					Na_2SO_4 (%)			
	0.0	0.1	0.2	0.3	0.4	0.1	0.2	0.3	0.4
4	0.46	0.38	0.38	0.46	0.43	0.54	0.40	0.49	0.44
8	0.47	0.54	0.51	0.58	0.44	0.54	0.52	0.59	0.59
12	0.55	0.58	0.56	0.54	-	0.57	0.62	0.68	0.56

Table 2 : a+b/Total ratios of whear seedlings treated with NaCl or Na_2SO_4.

Age (Day)	NaCl (%)					Na_2SO_4 (%)			
	0.0	0.1	0.2	0.3	0.4	0.1	0.2	0.3	0.4
4	0.67	0.40	0.56	0.66	0.87	0.76	0.68	0.69	0.66
8	0.71	0.74	0.69	0.84	0.88	0.74	0.80	0.76	0.72
12	0.75	0.79	0.72	0.79	-	0.84	0.75	0.77	0.74

Table 3 : a/b ratios of wheat seedlings treated with NaCl or Na_2SO_4

Age (Day)	NaCl (%)					Na_2SO_4 (%)			
	0.0	0.1	0.2	0.3	0.4	0.1	0.2	0.3	0.4
4	2.17	1.96	2.04	2.30	0.98	2.39	1.47	2.44	2.02
8	1.92	2.64	2.86	2.22	1.00	2.66	1.82	3.50	3.95
12	2.85	2.79	3.55	2.19	-	2.07	4.98	8.02	3.15

تاثير نوعين مختلفين من الطوحة على اصباغ البناء الضوئى فى نبات القمح

السيد احمد مرسى حماده ويوسف عابد حسن محمد
وبهية عبد السلام عبد الغفار

احدثت التركيزات المختلفة من كلوريد الصوديوم وكبريتات الصوديوم (٠,١ ، ٠,٢ ، ٠,٣ ، ٠,٤٪) زيادة فى كلوروفيل ا ، كلوروفيل ب ، لبادرات القمح سخا ٦٩ فى عمر اربعة وثمانية ايام • وفضلاعن ذلك ، الكاروتينات والاصباغ الكلية تزيد مع التركيزات المختلفة لكبريتات الصوديوم ، ومع تركيزى ١ ,٠ ، ٢ ,٠٪ من كلوريد الصوديوم لنفس الفترتين الزمنيتين المذكورتين آنفا •

لقد وجد ان نسبة كلوروفيل ا/ المحتوى الكلى للاصباغ تزيد عن ٥٠٪ فى التركيزات المختلفة لكبريتات الصوديوم • وهذه النسبة اقل فى حالة التمليح بملح كلوريد الصوديوم وهذا يؤكد ان زيادة المحتوى الصبغى حدث من خلال الزيادة فى كلوروفيل ا •

ولقد اثبتت الاختبارات الاحصائية وجود اختلافات معنوية نتيجة عمر البادرات وبين التركيزات المستخدمة فى اغلب الاحوال •