Organic Farming By Using Saharan Soil: Could It Be An Alternative To Fertilizers?

Sahra Çöl Toprağı ile Organik Tarım: Gübrelere Bir Alternatif Olabilir mi?

Research Article / Araştırma Makalesi

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ABSTRACT

It has been shown that Saharan soil may have the potential of producing bioavailable iron when illuminated with visible light and also it has some essential macro and micro nutrient elements. In this study the impact of various growth media on development of some bread wheat (*Triticum aestivum* L.) and durum wheat (*Triticum durum* L.) cultivars have been investigated. As a four different nutrient media, Hewitt nutrient solution [1], illuminated and non-illuminated Saharan desert soil solutions and distilled water have been utilized. Shoot length (cm.seedling^{-1}), leaf area (cm^2 seedling^{-1}) and photosynthetic pigments [chlorophyll a, chlorophyll b and carotenoids, mg ml^{-1} g fresh weight (g fw)$^{-1}$] have been determined. The results of this study indicate that, wheat varieties fed by irradiated Saharan soil solution gave comparable results to Hewitt nutrient solution.

Key Words
Saharan desert soil, natural fertilizers, bread and durum wheat (*Triticum sp.* L.), seedling, photosynthetic pigments.

ÖZET

Sahra toprak çözeltisinin görünür ışık ile aydınlatıldığı zaman biyolojik kullanılabilir demir üretme potansiyeline sahip olabileceği gösterilmiştir, ayrıca bu toprak bazı temel makro ve mikro besin öğeleri içermektedir. Bu çalışmada, farklı besin ortamlarının ekmeklik buğday (*Triticum aestivum* L.) ve makarnalık buğday (*Triticum durum* L.)'ın bazı çeşitlerinin fide gelişimi üzerine etkileri araştırılmıştır. Besin ortamı olarak; Hewitt besin çözeltisi, ışıklandırılmış ve karanlıkta bırakılmış Sahra çöl toprağı çözeltisi ve deiyonize su kullanılmıştır [1]. Fide uzunluğu (cm.fide^{-1}), yaprak alanı (cm^2.fide^{-1}) ve fotosentetik pigmentler (klorofil a, klorofil b ve karotenoidler (c+x), mg.ml^{-1} g taze ağırlık^{-1}) belirlenmiştir. Bu çalışmanın sonuçları göstermektedir ki, aydınlatılmış Sahra toprak çözeltisi ile beslenen buğday çeşitleri Hewitt besin çözeltisi ile karşılaştırılabilir sonuçlar vermiştir.

Anahtar Kelimeler
Sahra çöl toprağı, doğal gübreleme, ekmeklik ve makarnalık buğday (*Triticum sp*. L.), fide, fotosentetik pigmentler.

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INTRODUCTION

One-one and half billion tons of dust are thrown from the Saharan desert and scattered to the atmosphere each year. Dust originating from the Saharan Desert could initiate a series of reactions upon contact with cloud water and results in the formation of reduced iron (Fe^{2+}), oxalate and various basic amino acids. Microorganisms rather their by products such as basic amino acids, Fe^{2+}, oxalate generated during the transportation of Saharan dust in the atmosphere where sun light and water from cloud where easily accessible and the microorganisms began multiplying [2,3].

It has been shown that during the dust transport events besides fine clay particles bacteria and fungi's also being carried away and upon contact with cloud water series of reactions takes place within the cloud droplet with the assistance of solar insolation [2]. It has been shown that such reactions enhance the bioavailable iron concentration as well as amino acids within the cloud [3]. The rate controlling step is the production of oxalate by the bacteria and fungi's present within the dust veil as well as type of iron mineral. Since the experiments carried out with ^{60}Co gamma rays irradiated dust samples did not yield any bioavailable iron as well as other soil samples. Besides the photochemical production of Fe^{2+} as well as producing some other essential nutrient elements like Zn, Mn along with PO_4^{3-} [2].

Sulzberger and Laubscher have shown the light-induced dissolution and the photochemical production of Fe^{2+} by using Lepidocrosite and oxalate as a reductant based on the assumption that oxalate present in atmospheric waters due to anthropogenic sources [4]. Recently, Saydam and Senyuva suggested that desert soil can be a potential source of bioavailable iron through in cloud photochemical reduction of iron minerals assisted by the oxalate released by the fungi's present within the desert soil [2]. Hence, in nature, the temporal and spatial variability of the bioavailable iron delivered to the crust via rain may be controlled by in cloud photochemical reduction of desert origin dust assisted by the impact of oxalate released by fungus present within the desert soil. Saydam and Senyuva have further shown that, the basic process in the photochemical production of bioavailable iron through decarboxylation reaction involves simultaneous action of oxalate released by the fungus within the cloud droplet above some threshold solar radiation [2]. Therefore, the diurnal and latitudinal variations in the solar irradiation and the sporadic nature of the rain events along the path of the synoptic scale atmospheric depressions are the governing factor that determines the rate of bioavailable iron delivered to the crust.

Rainwater chemistry was monitored during a two years period (November 2003 – October 2005) for quantification of the atmospheric input over a small (70 km^2) rural Mediterranean watershed. Major ions contents (HCO_3^-, Cl^-, NO_3^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^+, and K^+) were determined by ion chromatography (IC), nutrients content (PO_4^{3-}, NO_3^-, NO_2^- and NH_4^+) and trace element contents (Al, B, Ba, Cd, Cr, Cu, Co, Li, Mn, Mo, Ni, Pb, Rb, Sr, U, V and Zn) were determined by ion-coupled plasma-mass spectrometer (ICP-MS) [5].

Thus following this work the scientific community is getting closer to conduct a large-scale experiment whereby clouds are seeded with desert dust during day time and subsequent blooming is monitored via specifically deployed "carbon explorers" in regions benefiting from wet deposition. Such carbon explorers can also be deployed at adjacent waters along the pathways of the atmospheric depression, which have benefited from "night time-wet" dust deposition and dry deposition only. After all we have the technology to be at the right place at right time of the day to seed the clouds with the correct composition of desert dust, which we call "cloud dusting"analoguous to, land irrigation, to sustain phytoplankton growth over the oceans, possibly with a stabilizing effect on climate, as suggested by Charlson et al [6].

At a global scale, the Sahara desert is the most important source of mineral aerosols. The native soil of the Amazon rainforest, because of the continual leaching of the soils by heavy daily rainfalls, is extremely limited in the vital mineral nutrients needed by the abundant tropical vegetation of the rainforest to survive and flourish. 2006 work showing that more than half of the dust needed for fertilizing the Amazon Rainforest is provided by the Bodélé depression [7]. The biogeochemical impact of desert dust also remains a matter of discussion regarding its contribution for different macro and micro nutrient elements to terrestrial and marine systems, and especially its potential fertilizing role for remote oceanic areas by supplying micronutrients as phosphorus and iron [8]. This natural source of bioavailable iron is very essential since for many years iron deficiency suggested to be a limiting oceanic micronutrient in some oceanic regions, away from lands [9]. One important part of this system is the iron cycle, in which iron-containing soil dust is transported from land through the atmosphere to the oceans, affecting ocean biogeochemistry and hence having feedback effects on climate and dust production.

Plants demand ~10^{-4}-10^{-8} M Fe^{3+} ions for normal growth, but, theoretically, only 10^{-17} M are soluble at pH 7. Iron is essential for the synthesis of chlorophyll and heme [10]. Chlorophyll pigments are integrally related to the physiological function of leaves. Therefore, variations in pigment content may provide information concerning the physiological state of leaves. Chlorophyll tends to decline more rapidly than carotenoids when plants are under stress or during leaf senescence. The antenna system (carotenoids and chlorophylls) absorb light energy and transfer it into the photosynthetic reaction center [11].

Hypothesis

If the conditions are favorable, following the photochemical production of reduced iron, having found the necessary ingredients bacteria and fungus goes into the second step as to fix the atmospherics nitrogen during the course of atmospheric transport of that specific synoptic scale meteorological event that may persist for days, resulting with the formation of essential amino acids, as shown by Mace et al [3]. It has been shown that Saharan desert raw soil has some essential macro- and micro nutrient elements [12].

Thus we suggest that during the transport of desert dust by any synoptic scale meteorological events, atmosphere is not only acting as a conveyer belt but rather interesting and so far unknown processes takes place within the cloud droplets, provided that the necessary conditions are met. Iron is one of the essential micro nutrient elements for the plants and it has been shown that desert soil has the capability of producing bioavailability iron when illuminated with visible light. Saydam (Pers comm.) suggested testing the impact of the end products of this natural process on various wheat cultivars since we have known the technology of imitating this natural process simply by illuminating the desert origin soil samples. Saydam (Pers comm.) further suggested that the all living organisms must have adapted themselves to utilize the end products of this natural process, at its own ratios, since this is an ongoing process for millions of years as deducted from the results of ice core studies. It has been well documented that during the past glacier times the air was substantially dustier [13]. Marine core sediments from west and east Africa also illustrated variation in the dust supply (2.8, 1.7 and 1 million years ago) corresponding to the high latitude glaciations. As to test the relative impact of illuminated desert origin soil, Hewitt nutrient solution [1] and deionized water used as two extreme control solutions. Having understood the mechanism which can lead us to enhance solutions with reduced iron and some other essential elements and amino acids it was decided to imitate this process artificially and to test its possible impact by using various seeds.

MATERIAL AND METHODS

Saharan Desert Soil Solution

In this research, Saharan desert raw soil samples taken from southern Tunisia, near Tozeur has been used. In laboratory the raw soil samples dried, sieved (30 mesh) and homogenized.

Mineralogical Analyses of Saharan Desert Soil Sample with X-Ray Diffraction (XRD) Technique

Saharan desert soil samples were analyzed by X-Ray diffraction (Philips W1140 model) using CuKα radiation and a gonimeter speed of 2/min at Hacettepe University, Department of Geological Engineering.

Analysis of Saharan Desert Soil Sample with Atomic Absorption Spectrophotometer and Ion Chromatography

200 g of Saharan desert soil samples were put into 2 L metric cylinder and filtered with cotton mesh and then centrifuged at 11000 rpm for 15 min. Atomic Absorption Spectrophotometer (Perkin Elmer 2280 model) and ion chromatography (Dionex 600 model) analyses of the liquid were taken immediately. These analyses were conducted in Hacettepe University, International Research and Application Center for Karst Water Resources.

Wheat Seeds

In this research, two bread wheats (*Triticum aestivum* L. var. *aestivum* cv. Bezostaya-1 "B-1" winter type and Çukurova-86 "Ç-86" spring type) and tree durum wheats (*Triticum turgidum* L. var. durum cv. Kızıltan-91 "K-91" winter type and Harran-95 "H-95" and Diyarbakır-81 "D-81" spring types) cultivars were used. Elite seeds of the cultivars were obtained from Central, South and South-East Agricultural Research Institute in Turkey.

Seeds were sterilized for 20 min in 4% sodium hypochlorite (NaOCl) solution, then rinsed with deionized water 2-3 times and imbibed in deionized water at 23 ± 1°C for 5 h. The imbibed seeds planted into pots (10x16 cm) containing perlit and were watered with related treatment solution when required. Plants were grown at 20/25°C day/night temperatures, 16/8 h light/dark periods light intensity near the top of the plants was 200 μmol m^{-2} sec^{-1} and at 45% humidity in a controlled growth chamber. All the experiments were carried out in the controlled growth cabinet throughout the experiments.

As a four different growth media; Hewitt nutrient solution, illuminated and non-illuminated Saharan desert soil solutions and deionized water have been utilized: For Saharan desert soil solutions (SDSS), 200 g of dried, sieved (30 mesh) and homogenized Saharan soil samples were mixed with 2000 ml of deionize water and illuminated Saharan with 500-Watt halogen light with a wavelength spectrum of 380-800 nm, at constant temperature (20°C) so as to simulate the encapsulated dust within a cloud droplet during the day time. During the course of the experiments no, in situ, Fe^{2+} measurements have been made but the system illuminated with visible light for more than three hours and it was assumed that Fe^{2+}/Fe^{3+} ratio has reached to a steady sate level after two hours of irradiation as suggested by Saydam and Senyuva [2].

Harvest Dates

During 30 days experimental period two harvest dates (H_1 and H_2) were used. Each was based on a growth stage which is shown below;

H_1, 2 leaf stage; the main axis had two expanded leaves

H_2, 3 leaf stage; the main axis had two expanded leaves

Each pot contained 12 plants, and 6 plants were harvested from the pot at each harvest date. It was not easy to avoid damaging the plants left in the pots, and on some occasions the root system of the harvested plant was not sampled correctly due to intertwining of the root system. Hence, it was decided not to harvest to roots but only the tops of the plants.

Shoot Length of The Seedling

Shoot length of seedling was measured (cm. $seedling^{-1}$) at harvest dates H_1 and H_2.

Leaf Area

Leaf area expansion is one of the fundamental processes of plant growth [14]. At the 3 leaf stage (H_2) leaf area of the second leaf (cm^2 $seedling^{-1}$) of the seedling was measured with a Filotecnica 236 plan meter [15].

Pigment Content

Photosynthetic pigments were extracted from six separate leaf samples in 100% acetone. The absorbance of the extracts was measured at 470, 644.8 and 661.6 nm using a Jen Wat 6105 UV/Vis. Spectrophotometer. The concentration of chlorophyll (Chl_a, Chl_b) and carotenoids [xanthophylls(x) + β-caroten] were determined and calculated using adjusted extinction coefficients [16] and expressed on a fresh weight basis. [Eqs. 1-3]:

$$Chl_a = (11.24 \times A_{661.6}) - (2.04 \times A_{648.8}) \quad (1)$$

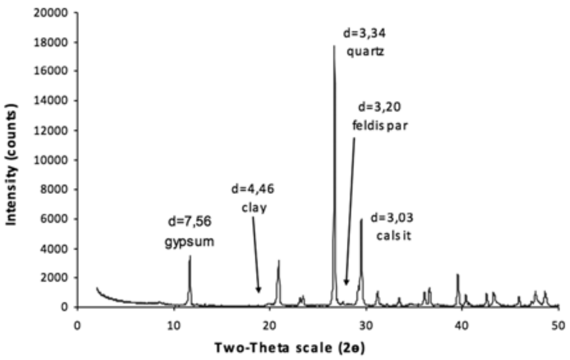

Figure 1. Mineralogic composition of Saharan desert soil.

$$Chl_b = (20.13 x A_{644.8}) - (4.19 x A_{661.6}) \quad (2)$$

$$Carotenoids_{(x+c)} = [(1000xA_{470}) - (1.9xChl_a) - (63.14 x Chl_b)] / 214 \quad (3)$$

Experimental Design and Statistical Analyses

The experiments were performed in randomized design. Statistical variance analysis of the independent data with six replicates (n=6) was performed by using the SPSS packet program and the differences between the means were compared with least significant differences at the 5% level (LSD £ %5).

RESULTS

Analyses of the Saharan Soil

In this study, the mineralogical compositions of clay sized particles are determined by the help of XRD [17]. Saharan soil sample was analyzed by XRD technique (x-ray diffraction technique) the dominant mineral was quartz, feldspar, calcite, gypsum and clay followed respectively (Figure 1).

Analyses of the Saharan Soil Solution

The determined element and ion contents (ppm) in Saharan soil solution were given below;

Fe =0.040, Mn =0.050, Zn =0.030, Ni =0.060, Cr =0.014, Pb =0.190 and Cd =0.02, NH_4^+ =1.60, K^+ =14.20, Ca^{2+} =460.00, Mg^+ =11.60, SO_4^{2-} =1168.00, Na^+ =55.70, Cl^- =40.00 and HCO_3^- = 43.30.

Morphological Parameters

Seedling length (cm/plant)

At H_1 and H_2, the length of seedlings of the cultivars were increased with Non-illuminated Saharan Desert Soil Solution (SDSS+NI), Illuminated Saharan Desert Soil Solution (SDSS+I) and Hewitt Nutrient Solution (HNS) compared to Deionized Water (DW): This effect was pronounced significantly with SDSS+I compared to DW, SDSS+I compared to SDSS+NI except in K-95 and HNS compared to SDSS+I except in B-1 and Ç-86 (Figure 2).

The determined growth parameters at Hewitt Nutrient Solution is accepted as 100 then the comparison of the growth parameters at different growth media to HNS were calculated as percentage.

At H_1, percentage values of seedling length for B-1 (91%) and Ç-86 (89%) in SDSS+I had the most closed value to HNS within the cultivars. At this stage, seedling lengths of the cultivars were

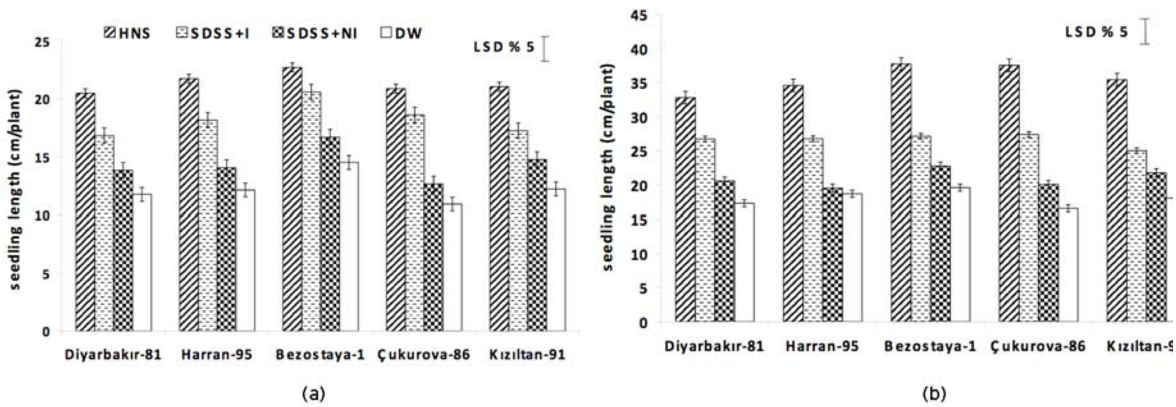

Figure 2. Effect of different growth media on the length of seedling at the second and third leaf stage (H_1 and H_2) for some bread and durum wheat cultivars (a), (b). Hewitt Nutrient Solution (HNS), Illuminated Saharan Desert Soil Solution (SDSS+I), Non-Illuminated Saharan Desert Soil Solution (SDSS+NI) and Deionized Water (DW). Vertical bars represent ± S.E. of the difference of means.

increased with HNS compared to DW about 36% (B-1) to 48% (Ç-86), and with SDSS+I compared to DW about 24% (K-91) to 37% (Ç-86).

At H_2, percentage values of seedling length for D-81 (81%) and H-95 (77%) in SDSS+I have the most closed value to HNS within the cultivars. Seedling lengths of the cultivars were increased with HNS compared to DW about 46% (H-95) to 66% (Ç-86) and with SDSS+I compared to DW about 20% (B-1) to 29% (D-81).

The seedling length response for HNS increased while for SDSS+I decreased compared to DW in the cultivars, at H_2 compared to at H_1. This result shown that the response to SDSS+I was decreased as growth progressed.

Leaf area ($cm^2.leaf^{-1}$)

Leaf area measurement was determined at the end of the experiment (H_2). Leaf area of the cultivars were increased with SDSS+NI, SDSS+I and HNS compared to DW, respectively: This effect was pronounced significantly with SDSS+I compared to DW, SDSS+I compared to SDSS+NI except in K-95 and HNS compared to SDSS+I (Figure 3.).

Percentage values of leaf area for H-95 (84%) and K-91 (83%) in SDSS+I had the most closed value to HNS within the cultivars. Leaf areas of the cultivars were increased with HNS compared to DW about 68% (H-95) to 74% (B-1) and with SDSS+I compared to DW about 36% (D-81) to 52% (H-95).

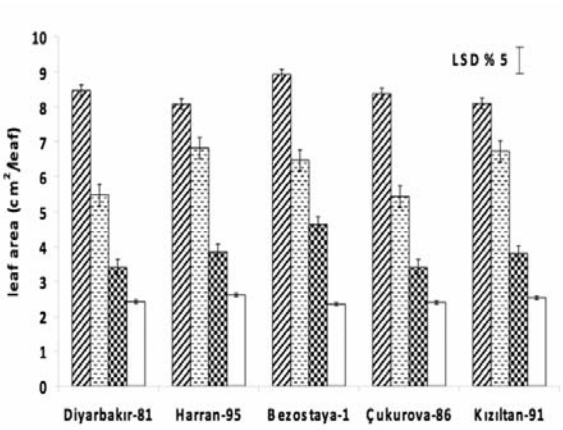

Figure 3. Effect of different growth media on leaf area of second leaf of seedling at H_2 for some bread and durum wheat cultivars (cm^2 $area^{-1}$). Symbols and abbreviations correspond to those in Figure 2.

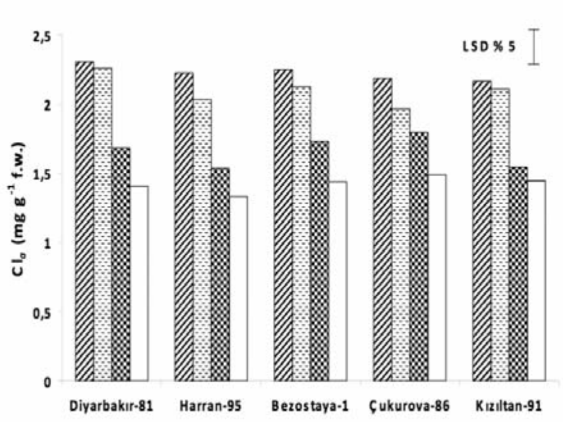

Figure 4. Effect of different growth media on Chl_a content of second leaf of seedling for some bread and durum wheat cultivars ($mg.g^{-1}$ fresh leaf weight). Symbols and abbreviations correspond to those in Figure 1.

Photosynthetic Parameters

$Chlorophyll_a$ content ($mg.g^{-1}$ fw)

At H_2, Chl_a content of second leaf of the cultivars were increased with SDSS+NI, SDSS+I and HNS compared to DW. This effect increased respectively (Figure 4.): This effect was pronounced significantly with SDSS+I compared to DW, SDSS+I compared to SDSS+NI (except in Ç-86). However SDSS+I was not differed significantly from HNS.

D-81 (98%) and K-91 (97%) in SDSS+I had the most closed value to HNS (100) within the cultivars. Chl_a content of second leaf of the cultivars was increased with HNS compared to DW about 32% (Ç-86) to 40% (H-95) and with SDSS+I compared to DW about 22% (Ç-86) to 37% (D-81).

$Chlorophyll_b$ content ($mg.g^{-1}$ fw)

At H_2, Chl_b content of second leaf of the cultivars showed also a similar response to Chl_a (Figure 5.): This effect was pronounced significantly with SDSS+I compared to DW and SDSS+I compared to SDSS+NI. However SDSS+I was not differed significantly from HNS. D-81 (99%) and B-1 (96%) in SDSS+I had the most closed value to HNS (100) within the cultivars. Chl_b content of second leaf of the cultivars were increased with HNS compared to DW about 12% (H-95) to 34% (K-91) and with SDSS+I compared to DW about 11% (H-95) to 29% (B-1).

$Carotenoids_{(x+c)}$ content ($mg.g^{-1}.fw$)

At H_2, a similar response to Chl_a and Chl_b was

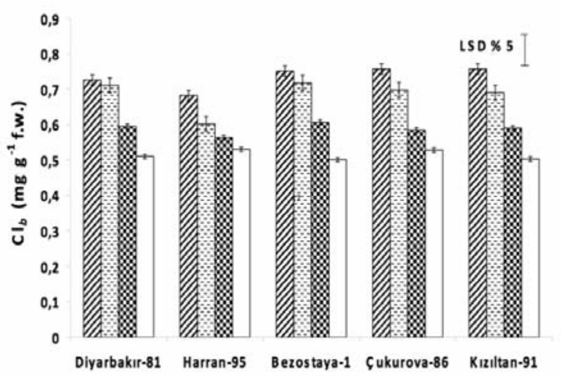

Figure 5. Effect of different growth media on Chl_b content of second leaf of seedling for some bread and durum wheat cultivars (mg.g^{-1} fresh leaf weight). Symbols and abbreviations correspond to those Figure 1.

also obtained in carotenoids$_{(x+c)}$ content of the second leaf of the cultivars was increased with SDSS+NI, SDSS+I and HNS compared to DW; respectively (Figure 6.): This effect was pronounced significantly with SDSS+I compared to DW, SDSS+I compared to SDSS+NI. However SDSS+I was not differed significantly from HNS.

D-81 (97%) and Ç-86 (96%) in SDSS+I had the most closed value to HNS (100) within the cultivars. Carotenoids$_{(x+c)}$ content of the second leaf of the cultivars was increased with HNS compared to DW about 32% (B-1) to 42% (H-95) and with SDSS+I compared to DW about 19% (B-1) to 34% (H-95).

In order to determine the excessive or deficient levels of the plant nutrients in non-illuminated SDSS the ratio of essential element content for HNS over

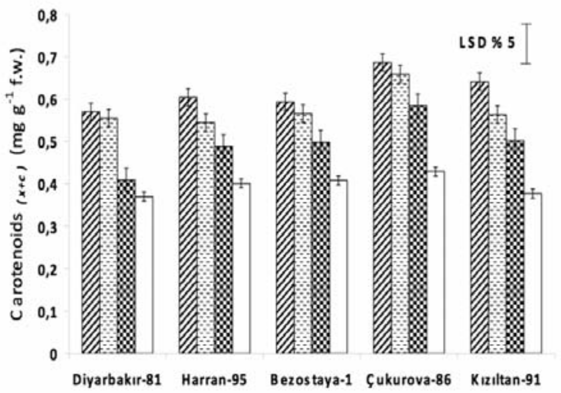

Figure 6. Effect of different growth media on Carotenoids$_{(x+c)}$ content of second leaf of seedling for some bread and durum wheat cultivars (mg.g^{-1} fresh leaf weight). Symbols and abbreviations correspond to those in Figure 2.

non-illuminated SDSS were examined (Table 1).

In this respect, Na, Ca, Cl and S elements were higher and Zn, Mg, K, Mn, N and Fe elements were lower in non-illuminated SDSS than in HNS and this effect increased in the given order. However, there was not any deficiency or toxicity determined through out the growth. Therefore this aspect has got to be examined by using different amount of SDSS in order to assess the utilizable amount of Saharan dust that for plant growth and development in future researches.

As shown in Table 2, D-81 was the most responded cultivar within the others for the determined parameters. Consequently, future research may be focused probably on D-81.

DISCUSSION

Mineral analyses of the used Saharan desert soil sample are composed of quartz, calcite, gypsum and feldspar. These results were agreed with literature [18]. Non-Illuminated Saharan desert soil sample had the most essential macro nutrients which analyses with atomic absorption spectrophotometer and ion chromatography. It has been reported that the photochemical reduction of Saharan soil causes the production of bioavaible of Fe, Mn, Zn and PO_4^{3-} elements [1]. Therefore nutritional values of illuminated and non-illuminated SDSS were examined with respect to HNS and DW. The effect of SDSS+I on seedling length, Chl_a, Ch_b and carotenoids$_{(x+c)}$ contents were very closed and not differed to that of HNS. The effect of SDSS+I on leaf area was not good as to that of HNS, but it was significantly higher to that of SDSS+NI and also to that of DW.

In addition to these, there was not any deficiency or toxicity symptom of the elements during the growth of the plant in illuminated and non-illuminated SDSS. We suggest that some kinds of antagonistic and synergistic effects among the elements in Saharan desert soil solution might present. Therefore mineral interactions of the elements in Saharan desert soil solution need to be investigated deeply which bring some new thought in plant breeding.

Table 1. Some essential element content (ppm) in Hewitt Nutrient Solution (HNS), and Non-Illuminate Saharan Desert Soil Solution (SDSS+NI) and their ratio.

Essential elements	HNS	SDSS+NI	HNS/ SDSS +NI
N	168.00	1.60	105.00
K	156.00	14.20	11.00
Ca	160.00	460.00	0.35
Mg	36.00	11.60	3.10
S	48.00	1168.00	0.04
Na	33.00	55.70	0.60
Mn	0.55	0.05	11.00
Zn	0.07	0.03	2.20
Cl	3.50	40.00	0.09
Fe	5.60	0.04	140.00

CONCLUSION

In this research the reaction products of the photochemical induced/not induced Saharan soil sample solutions were utilized in parallel with Hewitt nutrient recipe for growing wheat under controlled environment. Growth obtained by using deionized water utilized as a blank. The determined growth parameters were significantly higher in illuminated and non-illuminated SDSS than those in DW. In addition, very close results in the determinate growth parameters were obtained in illuminated SDSS to Hewitt. Thus for the first time it has been shown that comparable growth can be sustained by using Saharan desert soil samples and amongst the tested varieties Diyarbakır-81 gave the best response.

The other important outcome of this research is that the elemental ratios of Saharan soil samples compared to Hewitt nutrient solution: Within the desert soil samples some elements are quite high, some are inadequate and some others are absent thus one cannot expect a healthy growth of any plant. However, the results have shown that wheat seedling grow quite good as in Hewitt up to 30 days.

Following this study the spread of dust from desert regions through a meteorological events and associated rain events along its route should be investigated with great care since those cultivated areas not only receiving rain but also blessing with the end products of the in-cloud photochemical reduction mechanisms.

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Table 2. The most responded were given above by comparison of the seedling length at different growth media and Hewitt Nutrient Solution. First and second cultivars among the others (The determined growth parameters at Hewitt Nutrient Solution are accepted as 100).

Growth Parameters	Cultivars	
	1st	2nd
Seedling length	Diyarbakır-81 (%81)	Harran-95 (%75)
Leaf area	Harran-95 (%84)	Kızıltan-91 (%83)
Chla	Diyarbakır-81 (%98)	Kızıltan-91 (%97)
Chlb	Diyarbakır-81 (%99)	Bezotaya-1 (%96)
Carotenoids(x+c)	Diyarbakır-81 (%97)	Çukurova-86 (%96)

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