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# Effect of Incorporation of Date Palm Seeds with Soil on the Growth of Parsley Plant Growing under Drought Stress

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**Abstract:** Parsley was cultivated in a soil incorporated with 3% (w/w) fine crushed date palm seeds and irrigated either with 100% or 60% field capacity (FC). Incorporation at 100% FC led to increases in soluble sugars, soluble starch, non structural carbohydrates, protein, free amino acids, total nitrogen, photosynthetic pigments and photosynthetic efficiency, vitamin A, vitamin B complex ($B_1$, $B_2$, $B_3$, $B_6$), vitamin C as well as total oil, total lipids and the concentration of the estimated elements (N, P, K, Ca, Mg, Fe, Mn and S). Drought led to an accumulation in soluble carbohydrate, soluble starch, proline, free amino acids and the estimated elements but retarded the other investigated parameters. Interaction between crushed seeds and drought alleviated the bad effects of salinity.

**Key words:** Parsley · *Petroselinum sativum* · Drought · Field capacity · Date palm · *Phoenix dactylifera* · Soluble sugars · Soluble starch · Non structural carbohydrates · Proline · Amino acids · Protein · Carotenoids · Photosynthetic efficiency · Fatty acids · Minerals

## INTRODUCTION

Shortage of water is one of the most important problems which challenge agriculture causing drought stress. Desertification, desiccation and lack of rainfall cause the dominance of drought problem [1, 2]. Drought retards the plant growth leading to reduction in their yields. It disturbs plant metabolism causing inhibitions in total carbohydrates, total nitrogen contents and total lipids [3, 4].

Parsley (*Petroselinum sativum* Mill) is a familiar herb, widely employed as a culinary garnish for more than 2000 years, but it is seldom eaten. Its leaf, root and fruit have also been used for centuries in folk medicine. It is rich in its nutritive value as it has moisture 68.4 %, protein 5.9 %, fat 1 %, carbohydrates 19.7 %, fiber 1.8 %, minerals 3.2 %, calcium 390 mg/ 100g, phosphorus 200 mg/ 100g, iron 17.4%, carotene 3200 IU / 100 g, thiamine 0.04 mg/100 g, nicotinic acid 0.5 mg/100 g and ascorbic acid 218 mg/100 g [5].

It is applied for different medicinal uses (either for protection or for treatment) of some diseases such as anemia, bacterial infections,bad breath (as breathes freshener), baldness, diarrhea, GIT- troubles and Hyper cholesterolemia, edema, fatigue, gallstone, hormonal disturbance and jaundice. Parsley is also used as blood purifier, emmenagogue, abortifacient, blood vessel rejuvenator, digestive aid, diuretic(especially within renal stones), antioxidant, glandular support, immune booster, tumor formation inhibitor and as general tonic (specially for nervous system, vision and genital system) [6].

Seeds of date palm (*Phoenix dactylifera* L.) contains many constituents; (on a dry-weight basis) protein 5.56%, oil 10.19 %, Ash 1.15 % and total carbohydrate 83.1%. They also have multi important and vital minerals such as P 0.26%, K 0.75%, Ca 0.71%, Fe 141 ppm and Zn 48 ppm. These constituents made it a good fertilizer [7, 8].

The aim of this work is a trial to use fine crushed powder of date palm seeds as an alleviating agent to alleviate the bad effects of drought on parsley plant.

## MATERIALS AND METHODS

**Seeds:** Seeds of date palm (*Phoenix dactylifera* L. variety Zaghloul) were bought from Palm Research Institute (PRI), Agricultural Research Center (ARC), Giza, Egypt. They were air- dried then crushed mechanically and turned into fine powder. The seeds of parsley (*Petroselinum sativum* Mill variety Balady) were kindly provided from Horticulture Research Institute (HRI), Agricultural Research Center (ARC), Giza, Egypt.

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Table 1: Effect of different percentages incorporated dose of crushed date palm seeds (W/W) on total carbohydrate (mg/g d wt) and total nitrogen continents (mg/g d wt) of parsley plant (3-weeks old)

| Concentration % | Total Carbohydrate | Total Nitrogen contents |
|---|---|---|
| 0.0 | 0.29 | 0.16 |
| 0.25 | 0.31 | 0.18 |
| 0.5 | 0.35 | 0.21 |
| 1 | 0.36 | 0.21 |
| 2 | 0.38 | 0.22 |
| 3 | 0.43 | 0.24 |
| 4 | 0.43 | 0.24 |
| 5 | 0.44 | 0.24 |
| 6 | 0.43 | 0.24 |
| 7 | 0.43 | 0.24 |
| 8 | 0.44 | 0.24 |
| $LSD_{5\%}$ | 0.08 | 0.05 |
| $LSD_{1\%}$ | 0.11 | 0.07 |

Table 2: Effect of different field capacities (FC) on the fresh and dry weights of parsley plant (3-weeks old)

| F C | Fresh weight | Dry weight |
|---|---|---|
| 100 | 0.425 | 0.061 |
| 90 | 0.375 | 0.056 |
| 80 | 0.325 | 0.051 |
| 70 | 0.275 | 0.047 |
| 60 | 0.225 | 0.042 |
| 50 | 0.095 | 0.023 |
| 40 | 0.045 | 0.014 |
| $LSD_{5\%}$ | 0.004 | 0.002 |
| $LSD_{1\%}$ | 0.006 | 0.003 |

**Soil:** The used soil was a garden soil. The soil texture was a clay loam with organic carbon 0.91%, Total N 0.12%, C/N ratio 8.3, total P 0.072 and $CaCO_3$ 3.4%. The soil was air-dried then sieved through 2-mm sieve. 5 kilograms of the prepared soil was dispensed into black plastic pots (40-cm diameter x 50-cm height) to be ready for cultivation.

**Preliminary Experiments:** Two preliminary experiments were done. The first experiment was for determination the optimum dose of the crushed palm seeds can be incorporated with the soil in the main experiment. In this experiment, 55 pots were divided into 11 groups (each group had 5 replicates). The groups were incorporated with, 0.0, 0.25, 0.5. 1, 2, 3, 4, 5, 6, 7 and 8% of air dried crushed palm seeds (W/W) respectively. After 3 weeks, plants were harvested and subjected to analysis for determination of total carbohydrate [9] and total nitrogenous compounds [10]. The results, as shown in Table 1, indicated that the optimum concentration was 3% (W/W).

The second experiment was for determination of the maximum drought stress under which parsley seeds can be grown. In this experiment, 35 pots were divided into 7 groups (each group with 5- replicates). The field capacity range was 100%, 90%, 80%, 70%, 60%, 50% and 40% for group 1, 2, --- and 7, respectively. The adjustment of FC was carried out [11] every 24 hours at 7 AM. After 3 weeks, 60% FC was selected according to the data of fresh and dry weights, Table 2, as the maximum drought stress can be applied in the main experiment.

**Experimental Design:** The main experiment was divided into two groups; the first group was irrigated with 100% FC, while the second group was irrigated with 60% FC. Each group was subdivided into two classes, first class was not incorporate with the fine powder of the crushed date palm seed (served as control) while the second class was incorporated with 3% the fine powder of the crushed date palm seed (W/W), as each pot received 0.15 g/pot. Each class had 60 pots classified into 6 sets and each set had 10 (pots) replicates. Each pot was cultivated with 12 seeds. FC was adjusted daily throughout the experiment period. After 7 weeks all pots were harvested and subjected to the different investigational chemical analyses.

**Analysis:** First set was used for analysis of soluble sugar, soluble starch and total non structural carbohydrate [12]. Second set was used for determination of photosynthetic pigments [13, 14] and measuring of photosynthetic

efficiency [15]. Third set was used for determination of proline [16]; free amino acids [17]; protein [18] and total N [19]. Forth set was used for the estimation of fatty acids and oil concentration [20] and screening of the composition of the oil [21]. Fifth set was used for the determination of the concentrations of vitamin A [22] and for estimation of both vitamin B and vitamin C [23]. Determination of vitamins and individual fatty acids estimation were carried out in the Central Lab of Fodder, Agricultural Research Center (ARC), Giza, Egypt. The last set was used for determination of the concentrations of N, P, K, Ca, Mg, Fe, Mn and S [24]. Elemental determination was carried out in at Occupational Health Department, National Institute of Occupational Safety and Health (NIOSH), Cairo, Egypt. All obtained results were subjected to least significant difference (LSD) test [25].

## RESULTS AND DISCUSSION

In the first preliminary experiment, the soil was incorporated with serial concentrations (W/W) of the fine crushed date palm seeds to investigate the optimum concentration can be used in the main experiment. Data represented in Table 1 indicated that the concentration 3% was the first concentration which gave the maximum values of total carbohydrate and nitrogenous constituents, while the next concentrations have no significant records. The enhancement occurred in the growth of parsley plant can be referred to the presence of multi-minerals in the seed of palm [7, 8]. These minerals have many specific vital roles in the metabolic reactions such as P, K, Ca, Fe and Zn [26].

The data listed in Table 2 showed that, at 50% FC, a dramatic and severe retardation occurred in plant activities and this is because parsley is a drought sensitive plant [27]. The retardation can be attributed due to the shortage of the water inside the plant cell which needs water as a medium of most physiological and biochemical reactions inside plant cell specially hydrolysis and photosynthesis [28].

Incorporation of date palm seeds with the soil improved and enhanced the biosynthesis and production of the estimated carbohydrate fractions as shown in Table 3. Carbohydrate biosynthesis is controlled by several enzymes which depend on different minerals such as K, P and Fe. Presence of these elements in the crushed date palm seeds can enhance those reactions [29, 30]. Drought stress accumulated soluble sugars, soluble starch and non structural carbohydrate fractions. Such accumulation may be a method for lowering plant water potential to enable it to absorb excess water to overcome the shortage of the water soil [31]. Alleviation of the drought stress effects by incorporation of date palm seeds with the soil can be attributed to general activation occurred in the cell metabolism including carbohydrate biosynthesis [32].

Table 4 represents the effect the incorporation of soil with 3% (W/W) crushed date palm seeds on photosynthetic pigments and photosynthetic efficiency. Date palm seeds improved both of the pigment concentrations and their photosynthetic efficiency and this may be due to presence of P [33], Fe and Zn [28]. The inhibition occurred in both of pigments concentration and their efficiencies due to suffering of drought

Table 3: Effect of incorporation of soil with 3% (W/W) crushed date palm seeds on soluble sugars, soluble starch and non structural carbohydrate (NSC) as (mg glucose/ g d wt) of 7-weeks old parsley plant growing under 60% Field capacity

| Incorporation | F C % | Soluble sugars | Soluble starch | Non structural carbohydrate |
|---|---|---|---|---|
| Non incorporated | 100.00 | 7.95 | 7.27 | 15.22 |
| | 60.00 | 9.53 | 8.77 | 18.30 |
| Incorporated | 100.00 | 11.09 | 10.38 | 21.47 |
| | 60.00 | 12.65 | 11.76 | 24.41 |
| $LSD_{5\%}$ | | 1.37 | 1.85 | 1.29 |
| $LSD_{1\%}$ | | 1.95 | 2.64 | 1.84 |

Table 4: Effect of incorporation of soil with 3% (W/W) crushed date palm seeds on photosynthetic pigments(as mg / g d wt) and photosynthetic efficiency as (mM ferricyanide/ mg chlorophyll) of 7-weeks old parsley plant growing under 60% Field Capacity

| Incorporation | F C % | Chl. a | Chl. B | Carotenoids | Total pigments | Photosynthetic efficiency |
|---|---|---|---|---|---|---|
| Non incorporated | 100.00 | 0.922 | 0.608 | 0.299 | 1.829 | 34.589 |
| | 60.00 | 0.722 | 0.455 | 0.214 | 1.391 | 24.736 |
| Incorporated | 100.00 | 1.083 | 0.684 | 0.341 | 2.108 | 39.515 |
| | 60.00 | 0.841 | 0.531 | 0.256 | 1.628 | 29.662 |
| $LSD_{5\%}$ | | 0.025 | 0.017 | 0.008 | 0.021 | 1.432 |
| $LSD_{1\%}$ | | 0.036 | 0.024 | 0.011 | 0.030 | 2.038 |

Table 5: Effect of incorporation of soil with 3% (W/W) crushed date palm seeds on proline, free amino acids, protein and total nitrogen (TN) (as mg / g d wt) of 7-weeks old parsley plant growing under 60% Field capacity

| Incorporation | F C % | Proline | Amino acids | protein | TN |
|---|---|---|---|---|---|
| Non incorporated | 100.00 | 0.129 | 0.940 | 7.870 | 16.910 |
| | 60.00 | 0.323 | 2.290 | 6.750 | 14.520 |
| Incorporated | 100.00 | 0.132 | 1.320 | 10.090 | 21.690 |
| | 60.00 | 0.226 | 2.260 | 8.940 | 19.290 |
| $LSD_{5\%}$ | | 0.002 | 1.321 | 2.062 | 1.583 |
| $LSD_{1\%}$ | | 0.003 | 1.880 | 2.934 | 2.253 |

Table 6: Effect of incorporation of soil with 3% (W/W) crushed date palm seeds on fatty acids and total lipids (mg / g d wt) of 7-weeks old parsley plant growing under 60% Field capacity

| Incorporation | F C % | Fatty acids | Oil |
|---|---|---|---|
| Non incorporated | 100.00 | 1.218 | 1.664 |
| | 60.00 | 0.984 | 1.353 |
| Incorporated | 100.00 | 1.687 | 2.314 |
| | 60.00 | 1.453 | 1.993 |
| $LSD_{5\%}$ | | 0.086 | 0.118 |
| $LSD_{1\%}$ | | 0.122 | 0.168 |

Table 7: Effect of incorporation of soil with 3% (W/W) crushed date palm seeds on the relative concentration of the principle components of the oil extracted from 7-weeks old parsley plant growing under 60% Field capacity

| Incorporation | F C % | α-Pinene | β-Pinene | β-Myrcene | α -Phellandrene | *p*- Cymene | β - Phellandrene | Trpinolene + *p*- Cymenene | 1,3,8- *p*-Menthatriene | β -Elemene | Myristicin | Apiole | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non | 100.00 | 4.14 | 3.41 | 5.11 | 0.97 | 0.61 | 23.67 | 9.14 | 2.86 | 0.64 | 26.96 | 5.73 | 83.24 |
| incorporated | 60.00 | 4.12 | 3.41 | 5.11 | 0,96 | 0.62 | 23.62 | 9.14 | 2.88 | 0.64 | 26.25 | 5.21 | 81.96 |
| Incorporated | 100.00 | 4.13 | 3.42 | 5.10 | 0.96 | 0.61 | 23.61 | 9.13 | 2.87 | 0.64 | 26.17 | 5.34 | 81.98 |
| | 60.00 | 4.13 | 3.41 | 5.11 | 0.96 | 0.61 | 23.59 | 9.13 | 2.88 | 0.64 | 26.45 | 5.44 | 82.35 |
| $LSD_{5\%}$ | | 0.035 | 0.056 | 0.038 | 0.031 | 0.028 | 0.034 | 0.045 | 0.043 | 0.028 | 0.031 | 0.021 | 0.103 |
| $LSD_{1\%}$ | | 0.050 | 0.080 | 0.054 | 0.044 | 0.040 | 0.048 | 0.064 | 0.061 | 0.040 | 0.044 | 0.030 | 0.147 |

stress may be attributed to closing of stomata to prevent transpiration [26, 28] or to the general inhibition occurred in all cell activities [32]. Alleviation of the effects of the drought stress by date palm seeds may be attributed to their elemental composition and their vital roles.

Viewing the data in Table 5 indicates that, drought stress led to the accumulation of proline and free amino acids, while protein and total nitrogen contents were retarded. The accumulation of these fractions may be considered as a mechanism for adjustment of cell sap osmotic potential enabling it for more water absorption [28], while the retardation occurred (in protein and TN) may be due to inhibition occurred in the process of the conversion of amino acids into protein i.e. protein biosynthesis [32]. Date palm seeds application improved all estimated parameters. This improvement may be due to the increment in the uptake of essential elements participating in the biosynthesis of those nitrogenous fractions such as P [34] and Zn [35].

Tables 6 and 7 represented the contents of fatty acids (total and individual) and total oil concentration extracted from parsley plant which is rich with its oil contents [36]. Incorporation of soil with date Palm seeds within its cultivated soil improved the oil biosynthesis and its production. This improvement may be attributed to the improvement occurred in photosynthetic activity and its metabolic byproducts [37]. Drought reduced the oil contents of parsley plant [38]. Such retardation may be attributed also to the disturbance of photosynthesis and enzymatic activities of the plant [39]. The screening of the oil as shown in Table 7 indicated that, there is no significant difference between the fractions either due to the effect of incorporation with date palm seeds or due to drought application. This non significant difference may be explained as both of activation and retardation was a general and not specific for certain composition. This explanation is congruent with the general activation or retardation occurred in the last investigated parameters.

Vitamins are widely distributed in plant tissues [26] and parsley is one of the richest plants with vitamins [5]. Table 8 showed that incorporation of soil with the powder of the date palm seed improved and enhanced the biosynthesis of all investigated vitamins. Such improvements and enhancements may be attributed to the activation occurred in photosynthesis, protein and fatty acids which act as precursors for vitamin biosynthesis [26]. On the other hand, drought reduced and inhibited these vitamins and these occurred reductions and

Table 8: Effect of incorporation of soil with 3% (W/W) crushed date palm seeds on vitamin A vitamin, B complex [$B_1$, $B_2$, $B_3$, $B_4$] as (µg / g f wt) and vitamin C as (mg/ g f wt) of 7-weeks old parsley plant growing under 60% Field capacity.

| Incorporation | F C % | Vita. A | Vita. $B_1$ | Vita. $B_2$ | Vita. $B_3$ | Vita. $B_4$ | Vita. C |
|---|---|---|---|---|---|---|---|
| Non incorporated | 100.00 | 876 | 17 | 26 | 40 | 30 | 169 |
| | 60.00 | 845 | 14 | 21 | 35 | 26 | 142 |
| Incorporated | 100.00 | 922 | 19 | 29 | 43 | 32 | 194 |
| | 60.00 | 861 | 16 | 24 | 37 | 28 | 154 |
| $LSD_{5\%}$ | | 2.176 | 0.723 | 0.614 | 0.537 | 0.381 | 1.065 |
| $LSD_{1\%}$ | | 3.096 | 1.029 | 0.874 | 0.764 | 0.542 | 1.515 |

Table 9: Effect of incorporation of soil with 3% (W/W) crushed date palm seeds on N (as mg/g d wt), P, K, Ca, Mg, Fe, Mn and S (as µg/g d wt) of 7-weeks old parsley plant growing under 60% Field capacity.

| Incorporation | F C % | N | P | K | Ca | Mg | Fe | Mn | S |
|---|---|---|---|---|---|---|---|---|---|
| Non incorporated | 100.00 | 35 | 129 | 497 | 257 | 43 | 103 | 72 | 124 |
| | 60.00 | 58 | 258 | 876 | 390 | 51 | 178 | 96 | 185 |
| Incorporated | 100.00 | 41 | 172 | 622 | 304 | 45 | 128 | 79 | 144 |
| | 60.00 | 49 | 215 | 752 | 348 | 48 | 154 | 88 | 168 |
| $LSD_{5\%}$ | | 1.871 | 1.191 | 1.043 | 1.462 | 1.734 | 1.874 | 1.093 | 1.155 |
| $LSD_{1\%}$ | | 2.662 | 1.695 | 1.484 | 2.080 | 2.467 | 2.667 | 1.555 | 1.644 |

inhibitions may be due to consumption the main bulk of the energy in the adjustment of the cell osmotic potential causing retardation in the other cell activities [4]. Alleviation of effect of drought stress by application of date palm seeds may be discussed due to the benefit and vital roles of the mineral constituents of this seed.

Table 9 showed that, parsley is rich in its mineral contents qualitatively and quantitatively [5] and the investigated elements (N, P, K, Ca, Mg, Fe, Mn and S) were increased due to application of date palm seeds. The presence of excess minerals in the root absorption zone may led to an accumulation of these minerals by passive transport [40] and this found may explain the accumulation of the minerals due to date palm application. On the other hand, drought increased the concentration of these minerals inside the tissue and this may be a mechanism for adjustment the osmotic potential of the plant cells to overcome the lowering of the osmotic potential of water soil [32]. Alleviation of the bad effect of drought by application of date palm seeds may be ascribed to vital roles of the mineral constituents of this seed [29, 32, 41].

Generally, incorporation of the soil with the date palm seeds improved and enhanced the growth and all estimated physiological and biochemical activities of parsley plant under normal conditions and also succeeded in alleviation of the negative effects of drought stress.

Finally, this work advises with incorporation of the soil with the date palm seeds especially under drought stress application to improve the quality of the cultivated plants.

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