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Phenological and Physiological Study of Six Cultivars of Ziziphus spp. Planted in Basra Province- Iraq.

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Abstract This study was conducted in a private orchard at Abu Al Khasib area in Basra province – Iraq, during the growing season (2013), to evaluate six cultivars of Ziziphus spp. Plant, phenologically and physiologically. The results confirmed a difference among the cultivars in some phenological characteristics, and a similarity in others. While in physiological characteristics, and a similarity in others. While in physiological characteristics the study showed a significant superiority of the Toffahi cultivar in its length, diameter and weight of fruits (4.00 cm, 3.26 cm and 7.30 g.) respectively and in its fruit dry weight percentage (42.38 %), while the Hindi cultivar was superior in the T.S.S., water content and phenols percentages (17.22, 67.36 and 2.21 %) respectively. But the Laimoni cultivar was superior in leaf area, adjustable total acidity percentage and calcium pectate percentage (6.78 cm^2, 0.81 % and 4.57%) respectively. While Bathri cultivar was significantly superior in total chlorophyll content (3.36 mg. 100^{-1} fresh weight). Whilst the rest of cultivars showed a variable differences among them.

Key words: Phenological, Physiological, Ziziphus , Cultivars, Basra.

1.Introduction

The plant Ziziphus belongs to the family Rhamnaceae, this genus includes more than 100 species, which are shrubs, or evergreen or deciduous trees, exhibit tropical, subtropical and temperate areas in the world (Johnston, 1975). The Ziziphus is one of evergreen trees grown in tropical, subtropical and warm moderated areas (Williams, 2006). This plant had received global interest, for been untapped fruitful trees with a big future (Pareek, 2001). It is a multipurpose tree, where its fruits are fresh edible, due to their high content of Vit. C, sugars, proteins, organic and amino acids, lipids and mineral salts; the trees may be used as fuel or wind breakers; besides to the medical properties of their leaves and bark (Nasir and Nabil, 2006). A global interest had increased towards this plant for been the optimal plant to be planted in arid and semi – arid lands (Arndit, 2000), while unfortunately its productivity never reached the commercial or global production in Iraq, also the Scientific Iraqi Studies about this plant still few despite its importance, especially nowadays which witness an extinction of many plant species used to be planted in Iraq governorates especially Basra. So, it must be break into the Scientific Field in a way to have an opportunity to sustain the remaining species of plants suitable with our environmental conditions of the province, including the Ziziphus. So, for this reason, this study has been conducted, to highlight the important cultivars planted under the environment of Basra, and to focus on the specific and chemical characteristics of each cultivar planted and widely dispersed in Basra, and to encourage the production of best cultivar in future.

2.Materials and methods

This study was conducted at a private orchard in Kut Jaffal District at Abu Al Khasib area in Basra Province- Iraq, in the growing season 2013, during April, 20th, 2013 to September, 5th, 2013, where six cultivars of Ziziphus spp. were selected as the most dominant cultivars un Basra province, dispersed in two species of the genus Ziziphus (Z. spina-christi and Z. mauritiana), were chosen, each species included three cultivars from the six selected, also each cultivar was in three replicates, where a single tree represented one replicate (See Table – 1).

Table 1: The cultivars included in the two Ziziphus spp. Under study.

Species	Its Cultivars
Ziziphus spina – Christi	Bathri, Mallasi, Laimoni
Ziziphus Mauritiana	Toffahi, Baidh Al Asfoor, Hindi

Samples of the experiment soil and irrigation water were analyzed to determine their components (See Tables – 2 and 3).

Table 2: Some chemical and physical features of the soil of experiment at Abu Al Khasib area (Kut Jaffal district). *

Features		Values	
Potential of Hydrogen (pH)		7.20	
Electrical Conductivity (E.C.)		4.59 ($Ms.cm^{-1}$)	
Exchange Capacity of Cationic Ions		19.91 ($Centimole.kg^{-1}$)	
Organic Matter (O.M.)		13.67($g.kg^{-1}$)	
Calcium Carbonate ($CaCO_3$)		227 ($g.kg^{-1}$)	
Total Nitrogen (N)		5.14 ($g.kg^{-1}$)	
Available Phosphorus (P)		0.7 ($g.kg^{-1}$)	
Dissolved Potassium (K)		1.97 ($g.kg^{-1}$)	
Soil Texture	Sand	2.54 (%)	Silty Clay Soil
	Silt	61.66 (%)	
	Clay	35.80 (%)	

*Samples were analyzed at the laboratories of College of Agriculture, University of Basra.

Table 3: Some chemical and physical features of Irrigation water of the experiment. *

Features	Values
Electrical Conductivity (EC)	5.02 ($Ms.cm^{-1}$)
Potential of Hydrogen (pH)	7.91
Chloride Ion (Cl^-)	1877 ($mg.L^{-1}$)
Sodium Ion (Na^+)	16.33 ($mg.L^{-1}$)
Calcium Ions (Ca^{+2})	156 ($mg.L^{-1}$)
Magnesium Ions (Mg^{+2})	161 ($mg.L^{-1}$)
Sulfate (SO^-_4)	2213 ($mg.L^{-1}$)

*Samples were analyzed at the laboratories of College of Agriculture, University of Basra.

2.1. Phenological characteristics of studied cultivars Some phenological characteristics were recorded after a field observations for the six cultivars, these characteristics were: first and second flowering dates, fruits ripening date, type of fruit ripening and the shape, colour and taste of fruits during the ripening stage

2.2. Vegetative characteristics: of studied cultivars

2.2.1. Leaf area (cm^2) Measured according to Dvoring (1965) equation, where a modification in the measurement in term of weight were done, where the third leaves were drawn onto a transparent paper, their shapes then were cut, weighted and compared with a (1 cm^2) leaf area weight. The samples were taken during the ripening stage. The following is the equation:

$$S = \frac{G \times s}{g}$$

S= Leaf area (cm2)

G= Leaf weight (g.)

s= area of the cut square (cm2)

g= average of the cut square weight (g.)

2.2.2. Total Chlorophyll ($mg.100g.^{-1}$) Determined in leaves during the ripening stage in term of fresh weight, according to Howrtiz (1975) procedure described by Abbas and Abbas (1992), where the pigment been extracted by using 80 % acetone and estimated with spectrophotometer at 663 nm and 645 nm wave lengths, then the quantity of total chlorophyll was determined according to the equation:

Total Chlorophyll ($mg.100\ g.^{-1}$) = 20.2 × D (645) + 8.02 × D (663).

Where (D) represents the spectrophotometer reading at wave lengths (645 and 663 nm).

2.3. Productivity (Fruitis) Characteristics

2.3.1. Length and Diameter of Fruit (cm) Measured by selecting a random sample (30 fruits) from each cultivar for each replicate, then the vernier were used to measure both length and diameter

2.3.2. Fruit Weight (g.) The averages of weight were listed for the same above random sample using sensitive balance.

2.3.3. Water Content and Dray Matter of Fruit (%) In order to estimate these features, 30 g were taken from the flesh of ripe fruit for each replicate then dried under 75 °C in an oven for 48 hrs, or till the stability of weight, then the percentages found from the following equations:

$$\text{Water content (\%)} = \frac{\text{Fresh Weight} - \text{Dry Weight}}{\text{Fresh Weight}} \times 100$$

$$\text{Dry Matter (\%)} = \frac{\text{Dry Weight}}{\text{Fresh Weight}} \times 100$$

2.3.4. Adjustable Total Acidity (%) Estimated by titrating the samples against Phenolphthalein Dye as described by Howrtiz (1975).

2.3.5. Total Soluble Solids (T.S.S.) of Fruit (%) Measured as described in A.O.A.C. (1970) using hand refractometer, then the reading were adjusted under 20 ºC depending on special tables as described by (Howrtiz, 1975).

2.3.6. Calcium Pectate in Fruits (%) Estimated in terms of fruit dry weight (flesh and skin of fruits), as described in (Rouhani and Bassiri, 1976).

2.3.7. Phenols (%) To estimate the phenols in fruits the Folin – Ciocalteau method were used as described in Mohamad and Sallanon (2006).

2.4. Statistical Design and Analysis The data of experiment were designed according to the Randomized Completely Block Design (R.C.B.D.), as a one factor experiment which is the cultivar (six cultivars) each in three replicate, where each single tree considered as one replicate. The analysis of variance done by using the SPSS Statistical Program, and the comparison among the averages were done by using the Revised Least Significant Difference (R.L.S.D.) under a probability level of 0.05 according to Al Rawi and Khalaf Allah (2000).

3.Results and Discussion

3.1. Phenological Characteristics Table (4) shows some phenological characteristics of Ziziphus cultivars under study. The data reveal differences among the cultivars in some characteristics, while show similarities in others. It was clear that most cultivars were different in the first date of flowering, where in some cultivars, the flowers had bloomed directly at the beginning of September and lasted till the end of November (1/9 – 25/11) as in Bathri, Mallasi and Baidh Al Asfoor Cultivars, while other cultivars started blooming at the middle of September, lasted to the end of November (15/9 – 30/11) as in Laimoni, Toffahi and Hindi Cultivars. For the second date of flowering, no differences been noticed among all cultivars, where all of them bloomed at the beginning of May and lasted to the end of June (5/5 – 30/6). For the ripening date of fruits, a difference was found among the cultivars, where Toffahi was superior in its early ripening date which started from the begging of February and lasted till the end of March (5/2 – 24/3), comparing with other cultivars. In the second rank came the Baidh Al Asfoor cultivar which started ripening on (15/2 – 2/4), while the rest of cultivars were varied in ripening date. From the table (4) data showed that all cultivars belong to the species Z. spina-christi were late ripening cultivars (Bathri, Mallasi and Laimoni), Whilst all the cultivars belong to Z. mauritiana species were early ripening (Toffahi, Baidh Al Asfoor and Hindi). Data, also reveal a big variance among the cultivars regarding the fruit shape which was ranged (spherical, compressed semi-spherical, semi- cylindrical, inverted ovoid, broad-elliptic or elongated egg-shaped). Concerning the colour of fruits at the ripening stage it was ranged too (reddish green, yellow – orange, yellow, fading yellow or shining green – yellowish green). Also, for the taste of fruits at the ripening stage, the Toffahi and Baidh Al Asfoor Cultivars were distinguished very clearly (sweet with mild acidity and medium succulent nature) and (sweet with high succulent nature) respectively, comparing with the rest of cultivars which was ranged in taste (variable taste, acidic – medium sweet with low succulence, acidic – medium sweet with medium succulence or strongly acidic with high succulence).

Cultivar	1st flowering date	2nd flowering date	Fruit ripening date	Type of fruit ripening	Shape of fruit at ripening	colour of fruit at ripening	Taste of fruit at ripening
Bathri	1/9 – 25/11	5/5 – 30/6	25/3 – 30/4	Late	Semi-spherical	Reddish green	Variable taste
Mallasi	1/9 – 25/11	5/5 – 30/6	25/3 – 30/4	Late	Spherical – Compressed Semi-spherical	Yellowish – Orange	Acidic – medium sweet with low succulence
Laimoni	15/9 – 30/11	5/5 – 30/6	15/3 – 5/5	Late	Inverted ovoid lemon fruit-like	Yellow	Acidic – medium sweet with medium succulence
Toffahi	15/9 – 30/11	5/5 – 30/6	5/2 – 24/3	Early	Broad-elliptic – Semi-spherical	Fading yellow	Sweet with mild acidity and medium Succulent nature
Baidh Al Asfoor	1/9 – 25/11	5/5 – 30/6	15/2 – 2/4	Early	Semi-spherical – semi-cylindrical	Yellowish green	Sweet with high succulent nature
Hindi	15/9 – 30/11	5/5 – 30/6	5/3 – 20/4	Early	Semi-spherical to semi-cylindrical	Shining green – Yellowish green	strongly acidic with high succulence.

Table 4: Some phenological Characteristics of studied Ziziphus Cultivars.

3.2. Effect of Cultivar on Some Vegetative Characteristics [Leaf area (cm^2) and Total Chlorophyll ($mg.100\ g.^{-1}$)] in Ziziphus Plant leaves at the ripening stage The data in table (5) show a significant superiority of Laimoni cultivar in leaf area (6.78 cm^2) comparing with other cultivars, where Laimoni significantly did not differ from Toffahi (6.67 cm^2), while Bathri possessed the least leaf area (4.48 cm^2) which didn't differ from Baidh Al Asfoor (4.69 cm^2), whilst the other culti vars varied in leaf area. Concerning the total chlorophyll content in leaves, Bathri cultivar was significantly superior (3.36 mg. 100 $g.^{-1}$) and it wasn't differ from Mallasi and Laimoni (3.22 and 3.01 mg. 100 $g.^{-1}$) respectively, while in Baidh Al Asfoor the Chlorophyll content was (2.16 mg. 100 $g.^{-1}$) that didn't from Toffahi (2.48 mg. 100 $g.^{-1}$). These differences in leaf area total chlorophyll content among cultivars may be resulted from their genetic nature, besides to the effect of environmental factors on them.

Table 5: Effect of cultivar on Some Vegetative Characteristics (leaf area and total chlorophyll) of Ziziphus plant leaves at the ripening stage.

Cultivars	Species	Characteristics of leaf	
		Leaf Area (cm^2)	Total Chlorophyll (mg. 100 $g.^{-1}$)
Bathri	Z. spina-christi	4.48	3.36
Mallasi	Z. spina-christi	5.43	3.22
Laimoni	Z. spina-christi	6.78	3.01
Toffahi	Z.mauritiana	6.67	2.48
Baidh Al Asfoor	Z.mauritiana	4.69	2.16
Hindi	Z.mauritiana	5.46	3.07
R.L.S.D. (0.05)		1.01	0.37

3.3. Effect of Cultivar on the Productivity (Fruits) Characteristics

3.3.1. Length, Diameter and Weight of Fruits The increment in length, diameter and weight of the fruit are considered to be desirable traits for consumers, where they are changeable with fruit age, and not separatable from their size trait, because all these traits are strongly correlated during the physiological stages of fruit age (Shawky et al., 2001). So, concerning these characteristics, the data in table (6) reveal a significant superiority of Toffahi cultivar in fruit length (4.00 cm), while Bathri gave the least length (1.60 cm), while other cultivars were varied in their fruit length, this might be related to the genetic nature of cultivars. For the fruit diameter, the Toffahi also was significantly superior (3.26 cm), and wasn't differ from Laimoni (3.18 cm), also the least diameter (1.20 cm) was in Bathri too, while other cultivar possessed significant differences in fruit diameter, these results may be resulted from the genetic nature of cultivars, too. As for the fruit weight as affected by cultivar factor, it was clearly shown in table (6), and likewise, the Toffahi was the significant superior cultivar in fruit weight (9.30 g), which wasn't differ from Laimoni (8.57 g), while the least fruit weight found in Bathri (2.30 g). The increment in Toffahi fruit may be due to its high content of dry matter and T.S.S. (as shown in this current study), or because of its high content of endogenous hormones which reflected in an increment of growth and absorption of nutrients into the cells, then increased the weight of fruits.

Table 6: Effect of cultivar on length, diameter and weight of Ziziphus plant fruits at the final ripening stage.

Cultivars	Species	Characteristics of Fruits		
		Length (cm)	Diameter (cm)	Weight (g.)
Bathri	Z. spina-christi	1.60	1.20	2.30
Mallasi	Z. spina-christi	2.40	2.03	3.19
Laimoni	Z. spina-christi	3.20	3.18	8.57
Toffahi	Z.mauritiana	4.00	3.26	9.30
Baidh Al Asfoor	Z.mauritiana	2.40	1.38	2.67
Hindi	Z.mauritiana	2.80	1.70	3.57
R.L.S.D. (0.05)		0.67	0.09	1.01

3.3.2. Percentage of Water Content and Dry Matter in Fruits The data in table (7) indicated a significant superiority of Hindi cultivar concerning the water content of fruits (67.36 %), which didn't differ from Bathri (66.00%), while Toffahi possessed the least water content (57.62%), this result may be resulted from the genetic nature of cultivar. For the percentage of dry matter, Toffahi was significantly superior (42.38%), while the least dry matter found in Hindi (32.64 %), this result may be due to the high water content in Hindi cultivar and lowest water content in Toffahi (Current study).

Table 7: Effect of cultivar on the percentage of water content and dry matter of Ziziphus plant fruits

Cultivars	Species	Characteristics of Fruits	
		Water Content (%)	Dray matter (%)
Bathri	Z. spina-christi	66.00	34.00
Mallasi	Z. spina-christi	63.67	37.33
Laimoni	Z. spina-christi	61.91	38.09
Toffahi	Z.mauritiana	57.62	42.38
Baidh Al Asfoor	Z.mauritiana	64.83	35.17
Hindi	Z.mauritiana	67.36	32.64
R.L.S.D. (0.05)		2.31	1.37

3.3.3. Percentage of Total Soluble Solids (T.S.S.) and Adjustable Total Acidity in Fruits Data in table (8) confirmed a significant superiority of Hindi cultivar concerning T.S.S. (17.22%), which didn't differ from Toffahi (17.14%), while the least T.S.S. found in Bathri (12.17%), and about the rest of cultivars, they were varied in T.S.S. content; this result is in accordance with that found by Lang and During (1990), who indicated that the long day and high temperature especially during the ripening stage, may cause an increment in the percentage of T.S.S. as a result of increasing the content of Carbohydrates resulted from photosynthesis, this increment may be a big factor in increasing the T.S.S. in fruits.For the adjustable total acidity, the Laimoni cultivar was significant superior (0.81 %), which didn't differ from Baidh Al Asfoor (0.78 %), while the least acidity was Toffahi (0.39 %). This result may be a reflection of Toffahi earliness in its fruit ripening date than Baidh Al Asfoor, so this caused an increment in respiration of Toffahi and low consumption of organic acids during respiration.

Table 8: Effect of cultivar on the Percentage of Total Soluble Solids (T.S.S.) and Adjustable Total Acidity in Ziziphus fruits

Cultivars	Species	Characteristics of Fruits	
		Total Soluble Solids (%)	Adjustable Total Acidity (%)
Bathri	Z. spina-christi	12.17	0.53
Mallasi	Z. spina-christi	16.67	0.48
Laimoni	Z. spina-christi	15.37	0.81
Toffahi	Z.mauritiana	17.14	0.39
Baidh Al Asfoor	Z.mauritiana	15.66	0.78
Hindi	Z.mauritiana	17.22	0.77
R.L.S.D. (0.05)		0.97	0.04

3.3.4. Effect of Cultivar on the Percentages of Phenols and Calcium Pectate in Ziziphus Fruits Table (9) shows a significant differences among the different cultivars, where Hindi was significantly superior in phenols (2.21%) , which wasn't differ from Toffahi and Baidh Al Asfoor (2.19 and 2.18%) respectively. While the least phenols were in Mallasi (1.01%), which didn't differ from Bathri (1.13%). This decrease in phenols at the ripening stage for the studied cultivars of Ziziphus spp. was in accordance with AL-Izairjawi (1988) who confirmed this shortage of phenols content in ripe fruit of Ziziphus. For the effect on calcium Pectate percentage in fruits, the Laimoni was significantly superior (4.57 %), which wasn't differ from Bathri (4.41 %), where both cultivars belong to the species Z. Spina-christi. The least content of calcium Pectate found in Hindi (3.04 %), which belongs to the species Z. mauritiana. Besides, the cultivars Baidh Al Asfoor (3.66 %), Toffahi (3.63 %) and Mallasi (3.59 %) were non-significantly different among each another. From this result it migth be clear that the cultivars, which belong to the species Z. Spina-christi were of much calcium Pectate than those belong to the species Z. mauritiana, this case might be mainly due to the genetic nature of the studied cultivars.

Table 9: Effect of cultivar on the Percentage of Phenols and calcium Pectate in Ziziphus fruits

Cultivars	**Species**	**Characteristics of Fruits**	
		Phenols (%)	**Calcium Pectate (%)**
Bathri	Z. spina-christi	1.13	4.41
Mallasi	Z. spina-christi	1.01	3.59
Laimoni	Z. spina-christi	1.36	4.57
Toffahi	Z.mauritiana	2.19	3.63
Baidh Al Asfoor	Z.mauritiana	2.18	3.66
Hindi	Z.mauritiana	2.21	3.04
R.L.S.D. (0.05)		0.13	0.19

4.Conclusions and Recommendations From the results of this study it may be included that there was another cultivars, of Ziziphus spp., of high quality equal to that of Toffahi cultivar, which is commonly planted in Basra and other Provinces of Iraq. Also, the studied cultivars were varied among them phenologically and in their vegetative and productivity characteristics. So, the study recommends expanding the cultivation of Laimoni and Hindi cultivars, whether under the environmental conditions of Basra Province or other Iraqi Provinces.

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