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MORPHOLOGICAL STUDY (VEGETATIVE AND FLORAL) OF TWELVE DATE PALM MALE CULTIVARS

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Abstract

The study was conducted during the growing seasons of 2017 - 2018 on twelve date palm male cultivars in Samawah city, Muthanna Governorate, Iraq with the aim of identifying vegetative and floral characteristics, as well as the vitality of the pollen grains and their germination percentage for twelve males (Khadairy, Shalhoum, Ardawi, Bandar, Ereojan, Habiti, Fahl Zuhdi, Abu Kafisha, Atishi, Sweihi, Abu Tair, Nabhar). The study included 21 vegetative appearance characteristics and 19 floral appearance characteristics. The results showed differences among the male cultivars in the vegetative characteristics of the plant, in which, Bender cultivar recorded the highest length of leaf which was 500 cm. According to the analysis of the main components, the vegetative characteristics were divided into three main components. The male cv. Sweihi gave the highest percentage of pollen vitality which was 91.71% while Ereojan recorded the lowest percentage which was 85.94%. Bandar recorded the highest percentage of pollen germination which reached to 82.34%. In floral phenotypes, statistical obtained results indicated that floral characteristics divided into three main components. Habiti cv. gave the highest length of spadix which was 135 cm, while Sweihi cv. recorded the lowest value, which recorded 75 cm, The results of the study of the vegetative characteristics showed the degree of similarity among the male cultivars using cluster analysis. The male cultivar Khadairy was isolated from the other male cultivars and recorded the largest distance of the difference. The results of the cluster analysis clearly indicated that the male cultivars were grouped in two groups, the first included four male cultivars (Shalhoum, Ereojan, Fahl Zuhdi, and Atishi), and the highest similarities within this group were between Shalhoum and Ereojan.

Key words **:** Date palm, vegetative and floral characteristics, cluster analysis, pollen vitality.

Introduction

Date palm *(Phoenix dactylifera* L.) belongs to the family Arecaceae, which includes about 240 genus and about 4000 species (Ibrahim, 2008). Date palm is very similar in morphology and it is difficult for people who are not experts to find similarities and differences among cultivars (Al-Baker, 1972). There are some vegetative characteristics can be used to distinguish among cultivars such as trunk of date palm, the number of spines and their lengths, the length of the spines zone (Haider *et al*., 2015), whereas the date of appearance of spadixs, number and weight of spadixs, Number of spikes per spadix and other morphological characteristics can be used to distinguish among the spadixs of males (Groni, 2016). Morphological characteristics of vegetative or floral organs are still mainly used in the classification of plants and all aspects of the difference that can be imagined on leaves, stems, flowers, seeds, and pollen grains in classification considered as a basis in recognizing among cultivars (Al-Sabbagh and Al-Qadi, 2007; Judd *et al*., 2008).

In a study conducted by Shaheen *et al*., (1988) on 100 cultivars of male date palm trees in Saudi Arabia, which included some morphological characteristics (length of leaf, number and length of spines and numbers and length of pinnaes) recorded significant differences among the studied cultivars. In a study of some date palm cultivars in Tunisia using the analysis of the main components of the correlation among them, found that there were significant differences in the studied parameters (Hamza *et al.,* 2009).

The use of some statistical methods such as cluster analysis and analysis of the main components to study

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the similarities and differences between seed strains and some date palm cultivars by studying a range of vegetative characteristics enabled the differentiation of seed strains, female and male cultivars. (Hammadi *et al*., 2009; Ahmed *et al*., 2011; Abd, 2013).

The aim of present study is to distinguish among twelve male cultivars of date palm (Khadairy, Shalhoum, Ardawi, Bandar, Ereojan, Habiti, Fahl Zuhdi, Abu Kafisha, Atishi, Sweihi, Abu Tair and Nabhar) via vegetative and floral characteristics as well as the vitality of the pollen grains and their germination percentage, and to determine the relationship among cultivars by using cluster analysis

Materials and Methods

The study was carried out during the growing seasons of 2017-2018 and included 12 male and two female cultivars of date palms planted in the Samawah orchards, south west Iraq. The most well-known male cultivars in the region were selected, on which farmers depend on pollinating their orchards. Morphological characteristics for leaves and flower clusters which were appeared in table 1 were determined according to the methods used in the evaluation of date palms (Al-Baker, 1972). Measurements were performed on the palms by taking three leaves of 1 to 1.5 years of complete growth. Flower characteristics were calculated by taking three fully mature flower clusters before opening. flower clusters were collected at full maturity and before they were opened (plate 2). flower clusters of each cultivar were completely isolated from the rest to ensure that the pollen grains were not mixed with each other.

The results were statistically analyzed using the statistical SPSS program. The Principal Component Analysis was used to identify the characteristics affecting the variance (Mardia *et al*., 1979). The obtained results were used to determine the relationship between cultivars by using cluster analysis (Anderbeg, 1973). The mean differences were compared by using the least significant difference (L.S.D) test at the probability level of 0.05 (Bashir, 2003).

Results and Discussion

The vegetative study

The results indicated in Table 2 indicate that the male cultivars significantly differed in vegetative characteristics. In the length of the leaf, Bandar cv. recorded the highest value which was 500 cm while, Atishi cv. gave the lowest value of leaf length reached to 310 cm. In the length of the spine-free zone, there were no significant difference among Ereojan, Habiti and Abu

Table 1: Morphological studied characteristics.

No.	Vegetative characteristics	Floral characteristics
1	Leaf length	Number of spadix
2	Length of leaf base	Weight of spadix
3	Length of the spine-free zone	Length of spadix
4	Number of spines	Width of spadix
5	Mean of spine length	Length of pedicel
6	Length of the spine zone	Length of flower zone
7	Angle of the first spine	Number of spikes
8	Angle of the second spine	Length of first spikes
9	length of the pinnae zone	Length of second spikes
10	Number of total pinnae	Length of third spikes
11	Length of pinnae at the beginning of leaf	Number of flower for first spikes
12	Length of pinnae in the middle of leaf	Number of flower for second spikes
13	Length of pinnae at the end of leaf	Number of flower for third spikes
14	width of pinnae at the beginning of leaf	Length of flower zone for first spikes
15	width of pinnae in the middle of leaf	Length of flower zone for second spikes
16	width of pinnae at the end of leaf	Length of flower zone for third spikes
17	width of leaf	Length of the flower-free zone for first spikes
18	width of leaf base	Length of the flower-free zone for second spikes
19	Angle of the first pinnae	Length of the flower-free zone for third spikes
20	Angle of the second pinnae	
21	width of leaf base	
22	Circumference of trunk	

Table 2: Vegetative characteristics of male cultivars.

Male cv. (cm)	Leaf length	Width of leaf base (cm)	Length of the spine-free zone (cm)	Number of spines	Mean of spine length (cm)	Length of the spine zone (cm)	Length of pinnae at the beginning of leaf (cm)	Length of pinnae in the middle of leaf (cm)	Length of pinnae at the end of leaf(cm)	Width of pinnae at the beginning of leaf (cm)	Width of pinnae at the end of leaf (cm)
Khadairy	325	9	17	32	8	74	28	54	14	1.50	3.50
Shalhoum	433	10	32	29	10	130	37	50	23	1.00	4.00
Ardawi	384	14	27	41	7	110	26	50	13	2.00	3.50
Bandar	500	10	24	28	8	123	29	64	26	1.50	4.50
Ereojan	445	10	45	24	6	100	33	50	20.33	1.00	3.00
Habiti	423	13	43	17	9.25	100	30	50	27	1.50	5.00
Fahl Zuhdi	348	7	19	30	10	74	33	53	26	1.25	4.00
Abu Kafisha	445	13	42	24	6	70	23	54	30	1.00	3.50
Atishi	310	6	28	13	8	27	20	38	25	0.75	3.00
Sweihi	315	10	23	29	5	65	17	42	19	1.50	4.167
Abu Tair	380	11	17	34	6	110	23	43	19	1.00	4.00
Nabhar	357	11	39	22	5.30	48	29	57	28	1.50	3.50
LSD 0.05	7.819	2.383	3.227	2.179	0.678	4.865	2.919	4.589	2.635	0.1499	0.4655

Table 3: Contribution of vegetative characteristics in total variation.

No.	Characteristic	Contribution Ratio	No.	Characteristic	Contribution Ratio
1	Mean of spine length	0.981	12	Length of pinnae in the middle of leaf	0.945
2	Width of pinnae at the end of leaf	0.977	13	Length of the spine-free zone	0.940
3	Width of pinnae at the beginning of leaf	0.975	14	Width of leaf base	0.939
4	Leaf length	0.971	15	Angle of the second pinnae	0.930
5	Number of total pinnae	0.971	16	Angle of the first spine	0.927
6	Length of the spine zone	0.965	17	Length of pinnae at the end of leaf	0.922
7	Width of leaf	0.961	18	Width of leaf base	0.909
8	Width of pinnae in the middle of leaf	0.960	19	Length of pinnae at the beginning of leaf	0.888
9	Length of the pinnae zone	0.955	20	Angle of the second spine	0.870
10	Circumference of trunk	0.954	21	Angle of the first pinnae	0.861
11	Number of spines	0.947			

Kafisha which recorded the highest values at 45, 43 and 42 cm respectively with significant difference from the rest cultivars.

Shalhoum and Fahl Zuhdi were the best in recording the highest value in the Mean of spine length which was 10 cm for each of them. There was no significant difference among Khadairy, Bandar and Habiti in length of pinnae at the beginning, in the middle and at the end of leaf whereas, Ereojan and Fahl Zuhdi had no significant difference between them in length of pinnae at the beginning of leaf. Ardawi cv. recorded the highest values of the width of pinnae at the beginning, in the middle and at the end of leaf reached to 2 cm, while Habiti cv. gave the highest values in the middle and at end of the leaf which were 5, 3 cm sequentially. In the width of the leaf base, Sweihi, Abu Tair, Khadairy, Habiti and Fahl Zuhdi recorded the highest values 36, 35, 33 and 33 cm respectively, with no significant difference among them. Sweihi, Abu Tair, Ereojan and Fahl Zuhdi cultivars recorded the highest values in circumference of trunk which were 195, 193, 190 and 190 cm sequentially and without significant difference among them, while the Ardawi, Bandar and Shalhoum cvs. gave the lowest values reached to 125, 125, 130 cm sequentially and without significant difference among them. As for the Angle of the first spine, Khadairy, Shalhoum and Atishi

Table 4: Vegetative characteristics contributed to the main components of the variance.

No.	First component	24.12	Second component	15.36	Third component	8.43
1	Leaf length	0.953	Angle of the first spine	0.908	Mean of spine length	0.632
2	Length of leaf base	0.765	Angle of the second spine	0.777	Width of pinnae at the beginning of leaf	0.268
3	Length of the spine-free zone	0.657	Angle of the first pinnae	0.741	Width of pinnae in the middle of leaf	0.277
4	Number of spines	0.677			Width of pinnae at the end of leaf	0.205
5	Length of the spine zone	0.700			Angle of the second pinna	0.931
6	Length of pinnae at the beginning of leaf	0.802				
7	Length of pinnae in the middle of leaf	0.942				
8	Length of pinnae at the end of leaf	0.622				
9	Number of total pinna	0.958				
10	length of the pinnae zone	0.945				
11	Width of leaf base	0.565				
12	Circumference of trunk	0.771				
13	Width of leaf	0.829				

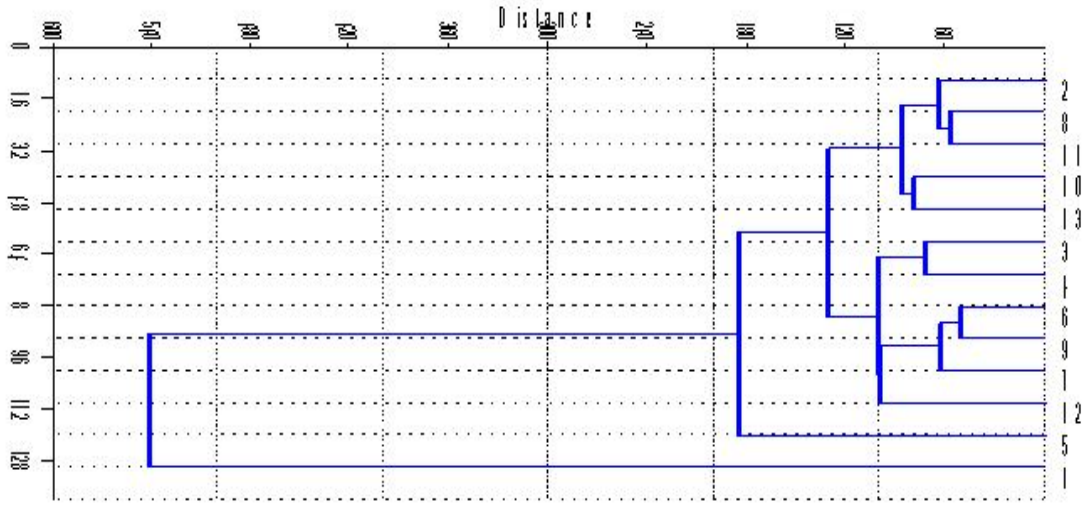

Fig. 1: The degree of similarity in the vegetative characteristics among the male cultivars using cluster analysis (1=Khadairy, 2=Shalhoum, 3=Ardawi, 4=Bandar, 5= Ereojan, 6=Habiti, 7=Fahl Zuhdi, 8=Abu Kafisha, 9= Atishi, 10=Sweihi, 11= Abu Tair, 12=Nabhar)

recorded the highest values of 40 for each cultivar.

In table 3, the contribution of each of the phenotypic characteristics in the total variance was recorded. The mean of spine length was the largest contribution at 0.981 followed by the characteristics of the width of pinnae at the end of leaf, the width of pinnae at the beginning of leaf and number of total pinnae. Angle of the first pinnae recorded the lowest contribution reached to 0.861.

Table 4 showed that characteristics divided into three main components and it is clear that the first component recorded the highest contribution percentage (24.12 %). This component included the length of the leaf, length of the base of the leaf, length of the spine-free zone, length of pinnae at the beginning, in the middle and at the end of leaf, number of the spines, length of the spine zone, number of total pinnae, length of the pinnae zone, width of leaf base, circumference of trunk and width of leaf . The second component contributed by (15.36 %), which included the angle of the first and second spine, and the angle of the first pinnae whereas, the third component contributed to the total variance by (8.43 %) and included

Table 5a: Floral characteristics of male cultivars.

Male cv.	Length of flower zone for first spike (cm)	Length of flower zone for second spike (cm)	Length of flower zone for third spike (cm)	Length of flower zone for first spike (cm)	Length of flower zone for second spike (cm)	Length of flower zone for third spike (cm)	Number of spikes	Number of spadix	Number of spadix
Khadairy	18	18	14	2	2	2	246	22	2100
Shalhoum	16	15	14	2	2	2	180	20	1000
Ardawi	13	12	11	2	2	2	275	22	900
Bandar	30	26	20.67	5	4	7	236	30	2006
Ereojan	14	10	8	2	2	1	208	30	1500
Habiti	21	21	20	1	1	1	300	32	3000
Fahl Zuhdi	13	13	12	5	5	5	110	20	1250
Abu Kafisha	16	16	16	4	4	4	179	25	2800
Atishi	19	17	16	3	2	2	220	23	1300
Sweihi	13	13	12	1	1	1	258	22	800
Abu Tair	14	13	11	7	7	9	280	30	1200
Nabhar	17	14	15	6	5	2	204	25	1600
LSD 0.05	2.229	1.884	3.619	1.192	1.088	1.538	29.580	2.528	137.6

Table 5b: Floral characteristics of male cultivars.

Male cv.	Length of spadix (cm)	Length of flower zone (cm)	Length of pedicel (cm)	Width of spadix (cm)	Length of first spike (cm)	Length of second spike (cm)	Length of third spike (cm)	Number of flower for first spike	Number of flower for second spike	Number of flower for third spike
Khadairy	95	45	50	15	20	18	16	51	43	48
Shalhoum	90	50	40	13	18	17	16	36	42	43
Ardawi	80	64	16	10	15	14	13	36	32	30
Bandar	120	66	54	15	35	30	31	71	69	68
Ereojan	100	50	50	15	17	12	9	42	37	32
Habiti	135	75	60	18	22	22	21	66	60	67
Fahl Zuhdi	90	52	38	12	18	18	17	39	33	37
Abu Kafisha	120	60	60	17	20	20	20	50	50	50
Atishi	90	50	40	14	22	19	18	65	53	61
Sweihi	75	65	10	10	14	14	13	45	46	43
Abu Tair	76	62	18	21	21	20	20	36	37	35
Nabhar	115	60	55	15	22	19	17	66	59	58
LSD 0.05	5.673	3.861	1.884	1.685	2.383	2.064	1.685	3.038	2.528	3.038

(Mean of spine length, width of pinnae at the beginning, in the middle and at the end of leaf and angle of the second pinnae).

Fig. 1 showed the degree of similarity in the vegetative characteristics among the male cultivars using cluster analysis. The male Khadairy was independent of the other males and recorded the largest distance of the difference. The rest of the males occurred in one group. It is noticeable that there is a convergence among the males in different degrees, the closest being the two cvs. Hibiti and Atishi, followed by the two cvs. Abu Kafisha and Abu Tair.

The effects of the environment, which include weather conditions and soil conditions, are reflected on the phenotypic parameters in different date palm growing regions. However, these effects are very limited in one region, which gives the phenotypic characteristics importance in distinguishing between male and female date palm cultivars. However, these characteristics are important in distinguishing among cultivars by their

Table 6: Contribution of floral characteristics in total variation.

No.	Characteristic	Contribution Ratio	No.	Characteristic	Contribution Ratio
1	Length of flower zone for third spike	0.988	11	Length of flower zone for first spikes	0.887
2	Length of flower zone for second spike	0.958	12	Width of spadix	0.882
3	Number of flower for third spike	0.945	13	Length of flower zone for third spike	0.867
4	Length of the flower-free zone for first spike	0.932	14	Number of flower for first spike	0.854
5	Number of flower for second spike	0.923	15	Length of flower zone	0.837
6	Length of flower zone for second spike	0.923	16	Number of spadix	0.831
7	Length of second spike	0.919	17	Number of spike	0.740
8	Length of spadix	0.915	18	Weight of spadix	0.695
9	Length of flower zone for first spikes	0.905	19	Length of pedicel	0.616
10	Length of third spike	0.892			

distribution to the main components of the variation. The results of the present study, which showed a difference in the studied vegetative characteristics of the date palm cultivars, were consistent with the results of Shaheen *et al*., (1988) that indicated to significant differences in the phenotypic characteristics of studied cultivars and with the study of Hamizi *et al*., (1998). Obtained results are in the same line with the study of Mohamed *et al.,* (2002) which showed that there were a significant variations among cultivars in the studied parameters, that included length and width of leaf, number of pinnaes, number of spines and length of spines. Results also in agreement with Ali *et al*., (2008), Hamza *et al*., (2009), Hammadi *et al*., (2009) and Mohamed *et al.,* (2011) who found variation in phenotypic characteristics when using component analysis. The study was consistent with the findings of Dahmawi (2015) and Groni (2016) who showed differences in the phenotypic characteristics of the studied male cultivars of date palm.

The floral study

The data shown in Table 5a, b indicated that male cultivars differed in floral characteristics. Habiti cultivar recorded the highest value in length of spadix which was 135 cm, while Sweihi cultivar recorded the lowest value which was 75 cm. In the length of the floral region, the cultivar Habiti was also superior to the rest of the cultivars, with a record of 75 cm, while the lowest value (45 cm) was in Khadairy cultivar . In the length of pedicel, Habiti and Abu Kafisha cultivars gave the highest value with a record of 60 cm each, while Sweihi recorded the lowest values of 10cm. Results showed that there was no significant difference between the two cultivars Khadairy and Ereojan which gave 50 cm each. Abu Kafisha recorded the same value (50 per spike) in the number of flowers in the first, second, and third spikes . It is noted in table 5b that the Bandar cultivar gave the highest values in the length of the floral region in the first, second and third spikes, reached to (30, 26, 20.67) cm sequentially. In the length of the floral-free zone in the first, second, and third spikes, Abu Tair recorded the highest values (7, 7 and 9 cm) sequentially, while the two cultivars Habiti and Sweihi recorded the lowest values of 1 cm for each of them.

Habiti cultivar was recorded the highest value in the number of spikes, which was 30 spikes per one spadix. In additions, Hibiti gave the highest value in a number of spadixs which recorded 32 spadixs with no significant differences with Bender, Ereojan and Abu Tair which gave 30 spadixs for each of them while, Shalhoum and Fahl Zuhdi cvs. gave the lowest values in a number of spadixs which was 20 spadixs for each of them. Habiti cultivar was superior to the rest cultivars by recording the highest value in the weight of spadix (3000 g), followed by Abu Kafisha, with 280 g, then Khadairy cultivar, with 2100 g. while Sweihi cultivars gave the lowest value which were 800 g.

Table 6 showed that the length of the flower-free zone for the third spike recorded the highest contribution at 0.988 followed by the length of the flower-free zone for the second spike and the number of flowers for the third spike. As a contribution to the total variation, the length of the Length of pedicel was 0.616.

The results of the analysis of components of floral characteristics (table 7) showed that the first component achieved 39.460% of the total variation, while the second component achieved 28.216% and the third component 19.211% of the total variance. The table showed that the characteristics within the first component are the most important that the distinction among the studied males depend on.

The results of the cluster analysis of floral characteristics (as shown in Fig. 2) showed the occurrence

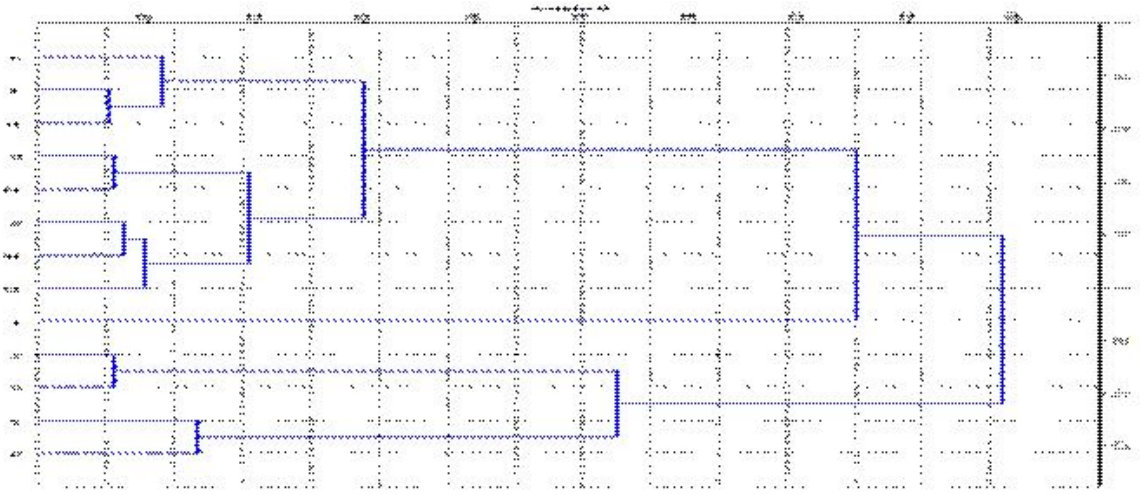

Fig. 2: The degree of similarity in the floral characteristics among the male cultivars using cluster analysis (1=Khadairy, 2=Shalhoum, 3=Ardawi, 4=Bandar, 5= Ereojan, 6=Habiti, 7=Fahl Zuhdi, 8=Abu Kafisha, 9= Atishi, 10=Sweihi, 11= Abu Tair, 12=Nabhar

Table 7: Floral characteristics contributed to the main components of the variance.

No.	First component	39.460	Second component	28.216	Third component	19.211
1	Length of spadix	0.935	Length of third spike	0.704	Length of first spike	0.753
2	Length of flower zone	0.813	Length of the flower-free zone for second spikes	0.655	Length of second spike	0.646
3	Length of pedicel	0.780	Length of the flower-free zone for third spikes	0.755		
4	Width of spadix	0.742				
5	Number of flowers for first spike	0.898				
6	Number of flowers for second spike	0.900				
7	Number of flowers for third spike	0.824				
8	Length of flower zone for first spikes	0.907				
9	Length of flower zone for second spikes	0.953				
10	Length of the flower-free zone for first spike	0.809				
11	Number of spikes	0.695				
12	Width of spadixs	0.672				
13	Weight of spadixs	0.828				

of male cultivars in two groups. The first included four male cultivars (Shalhoum, Ereojan, Fahl Zuhdi and Atishi). The highest similarities in this group were between the two male cultivars Shalhoum and Ereojan while, the second group included the rest of the male cultivars, which noted that Khadairy Kept away from the rest of the group and recorded the largest distance of the difference, while the rest of cultivars joined in two groups (sub-groups), and the two cultivars Bandar and Abu Tair more close compared to the rest of the males.

The number of spadixs in the male cultivars can be relied on in the distinction among them because the alternate bearing phenomenon does not occur compared to the female cultivars, in which the number of spadixs affecting by this phenomenon and can not be adopted in the distinction between them (Hilfi, 1993; Abdul, 2013). Results of the study were in the same line with Bukhae *et al.,* (1983) which found that the differences among

Table 8: Pollen grains vitality and their germination.

Cultivars	Vitality of pollen grains (%)	Germination of pollen grains (%)
Khadairy	86.53	81.66
Shalhoum	88.50	81.93
Ardawi	86.10	80.08
Bandar	90.08	82.43
Ereojan	85.94	77.75
Habiti	86.89	78.68
Fahl Zuhdi	88.54	77.11
Abu Kafisha	87.21	75.62
Atishi	89.01	77.20
Sweihi	91.71	79.02
Abu Tair	87.47	78.21
Nabhar	89.37	78.90
R.L.S.D 0.05	3.571	4.052

male cultivars in number of spadixs depended on cultivar and environmental conditions, and Nasr *et al*., (1986) in difference in weight of spadixs for male cultivars. The study also in agreement with the findings of Ali (1997); Iqbal (2009); Abud (2013 and Khalaf (2017).

Vitality and germination of pollen grains

The results presented in table 8 indicate that the male cultivar Sweihi gave the highest percentage of pollen grains vitality at 91.71%, significantly higher than the male cultivars Abu Tair, Abu Kafisha, Habiti, Khadairy and Ereojan which recorded the lowest percentage of pollen vitality which was 85.94%. Results indicated that there were no significant differences among the rest of the male cultivars in this characteristic. Bandar recorded the highest percentage of germination of the pollen grains of 82.34%, with significant difference to the Abu Tair, Ereojan, Atishi, Fahl Zuhdi and Abu Kafisha.

The difference in the vitality of the male pollen grains may be due to the weakness in the composition of the pollen grain or genetic defect in the maturity, and the results showed that not every pollen grain had the ability to germinate and may be due to a defect in the appearance of the pollen grain tube (Groni, 2016). The results of the present study were consistent with those mentioned by Abbas (2000), Osman *et al*., (2010), Aboudi (2012) and Dahmawi (2015) that indicated to the pollen grains variation in their vitality and germination percentage.

Conclusion

It is concluded from the study that there were differences among the male cultivars in the vegetative and floral characteristics and according to the analysis of the main components, the vegetative and floral characteristics were divided into three main components. The results of the cluster analysis clearly indicated that the male cultivars were grouped in two groups, the first included four male cultivars (Shalhoum, Ereojan, Fahl Zuhdi, and Atishi).

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