VOL. 3, NO. 8, August 2013 ISSN 2225-7217
ARPN Journal of Science and Technology

http://www.ejournalofscience.org

Study of the Floral Phenology and Inflorescence Characteristics of Selections of Olive obtained by Controlled Pollination in Relation to Climatic Conditions

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ABSTRACT

A breeding program has been developed since 1994 (done by Dr A. Trigui), by controlled pollinations of the Tunisian olive oil variety Chemlali Sfax in order to improve the qualities of this variety (higher oil percentage and a better chemical composition). These controlled pollinations have produced a population of new genotypes presented a wide genetic diversity which was very interesting for choice of future selections. The study was undertaken to obtain further information on morphological characters of inflorescence and phonological stages on some new olive selections obtained through self and free pollination of Chemlali Sfax. The impact of climatic conditions on the initiation date and the duration of bud break and full bloom was also investigated. Morphological characteristics of inflorescences showed a comparative variability between descendants within both type of pollination confirmed by higher variation coefficients (CV>20%) and significant differences ($p \leq 0.001$). Inflorescence length varied from 11.14 to 30.36 mm. Number of flowers per inflorescence was between 7.11 and 21.53. Percentage of perfect flowers ranged from 31% to 95%. Variability was also observed among olive descendants within crossings on the timing of phonological phase. Full bloom took place on average from April 3rd to May 15th. The period between formation of floral clusters and fruit set was 35-63 days long. A general anticipation of bud break and full bloom according the rainfall was noted. Thus, the present preliminary contribution on morphophenological study of Chemlali olive descendants provides information on potential and behavior of new genotypes with promising performances. Further investigation of floral biology, including other traits as the compatibility and fruit set will be carried out.

Keywords: *Olive tree seedlings, self-and free-pollination, phonology, inflorescence characteristics.*

1. INTRODUCTION

The olive tree (Olea europaea L.) is andromonoecious, i.e. individual trees bear both hermaphrodite and staminate flowers [1], which considered a cross-pollinator species preferably although self-fertilization, is not totally preclude [2]. Moreover, olive flowering and pollination progress remains dependent on weather conditions particularly temperature and rainfall [3]. All these meteorological conditions and genetic characteristics added to the cultivation technique present determinant factors of productivity. Thus, morphological and phonological studies on flowering of new genotypes provide important information, regarding the reproductive biology of olive species, both to behavior satisfactory production and to determine the most suitable future geographic vocation, pollination designs and agronomic techniques.

In the frame of a breeding program started in 1994 by Prof. A. Trigui, 1685 olive tree descendants obtained from controlled pollination are even under evaluation, among them 40 descendants were preselected for their oil percentage and acid composition [4]. However, oil quality traits of olive tree preselection are usually well described [5; 6] but information concerning inflorescence morphology and floral phonology are generally poor. For this reason, different morphological characters of inflorescence and direct observations of phonological stages have been analyzed on some olive descendants obtained through self and free pollination of Chemlali Sfax.

2. MATERIALS AND METHODS

The study was carried out on nine olive seedlings obtained from Chemlali free pollination and nine seedlings obtained from Chemlali self pollination. They were planted in 1997/1998 in the botanic orchard of Ettaous (in 23 km distance from Sfax, Tunisia with a rainfall of 220 mm/year). The olive trees were cultivated under identical agronomic and edapho-climatic conditions at a planting density of 2*4 m.

The observations and measurements were carried out on one tree per descendant. Forty representative inflorescences for each tree were collected at the stade 'E'. Inflorescence characters counted were: length (LFL: mm), number of flowers (NFL), number of perfect flowers (NPFL: well developed ovary) and number of floors of ramification (RFL). The percentage of perfect flowers (PPFL) was determined too. The phonology was characterized by direct observations carried out every week from 27-02-10 until 29-05-10. The phases recorded were: A (winter stage), B (bud break), C (inflorescence development), D (flower enlargement), E (corolla differentiation), F (onset of an thesis/the first flowers open), F_1 (full bloom), G (petal fall), H (fruit set), I (fruit growth 1st stage) and I_1 (fruit growth 2nd stage). These olive phonological stages are according to Colbrant and Fabre in [7]. The climatic data (daily rainfall, minimum and maximum temperature) was also collected

during the study period from the weather station installed in Ettaous.

Descriptive statistics analysis and coefficient of variation were conformed for all measured parameters. In addition, significant differences among descendants were determined by an analysis of variance (ANOVA) which applied a Duncan's test. The statistical analysis was performed using the SPSS 13.0.

3. RESULTS

Concerning the morphological characters of inflorescences, differences very highly significant ($p \leq 0.001$) among descendants within crossings stood out for all considered parameters (table1). Moreover, the variation coefficients calculated for all measured parameters are important (>20%) except the number of ramification floors.

The shortest and the longest inflorescence were recorded among seedlings obtained through self pollination with values equal to 11.14 and 30.36 mm respectively. The average number of flowers per inflorescence was between 7.11 and 21.53 recorded among Chemlali self pollination descendants. The percentage of perfect flowers ranged from a minimum of 31% noted among Chemlali free pollination to a maximum of 95% noted among those obtained through self pollination. The average number of ramification floors was comprised between 2.92 and 4.73 and showed that most Chemlali free descendants presented inflorescences type 4 (4 ramification floors) while those issued from Chemlali free pollination were dominated by inflorescences type 3 (3 ramifications floors).

Table 1: Mean range, maximum and minimum values, coefficient of variation (CV) and significance level for five morphological traits of inflorescence of Chemlali seedlings. Values underlined are the upper and lower extremes for each trait.

	LFL (mm)		**NFL**		**NPFL**		**PPFL (%)**		**RFL**	
Descendant	ChF	ChS	ChF	ChS	ChF	ChS	ChF	ChS	ChF	ChS
1	22,32	18,91	11,32	8,95	6,27	5,42	55	61	4,63	3,05
2	20,28	14,23	11,49	10,48	6,26	7,48	54	71	4,03	3,74
3	20,05	11,14	16,37	8,98	12,95	6,45	79	72	4,05	3,20
4	14,28	30,26	9,21	21,53	7,72	12,79	84	59	3,69	4,73
5	23,99	15,60	19,07	7,11	9,66	6,78	51	95	4,12	3,05
6	12,08	11,39	9,42	10,61	5,79	4,34	61	41	3,26	4,13
7	16,95	12,04	17,82	9,28	8,10	6,05	45	65	3,97	2,92
8	25,21	18,56	14,51	9,75	4,54	6,28	31	64	4,00	3,25
9	17,13	18,49	9,88	10,26	8,48	8,38	86	82	4,00	3,13
Min	12,08	11,14	9,21	7,11	4,54	4,34	31	41	3,26	2,92
Max	25,21	30,26	19,07	21,53	12,95	12,79	86	95	4,63	4,73
Mean	19,14	16,73	13,23	10,77	7,75	7,11	61	68	3,97	3,47
CV (%)	**22,99**	**35,58**	**28,70**	**38,75**	**32,22**	**34,08**	**30,60**	**22,39**	**9,09**	**17,58**
F calculated	152,78	391,87	127,48	194,94	22,09	37,63	32,43	24,19	30,68	117,33
Sig Level	***	***	***	***	***	***	***	***	***	***

LFL (inflorescence length), NFL (number of flowers), NPFL (number of perfect flowers), RFL (number of floors of ramification), PPFL (percentage of perfect flowers), CV (variation coefficient), *** (difference very highly significant $p \leq 0.001$), ChF (Chemlali free pollination descendants), ChS (Chemlali self pollination descendants).

Olive phonology in dataset followed for this preliminary study showed a considerable variability according to genotypes since all studied descendants were grown in similar pedoclimatic and agro technical conditions (table 2). Earlier bud break stage date was recorded on 27 February of ChF3 while the latest one on 10 April of ChF6. Full bloom took place on average from 3 April to 15 May; ChF3 was the earliest descendant to bloom; followed by ChS4, ChS9, ChF3 and ChF8 that flowered at the same time; afterwards ChS1, ChS2, ChS3, ChS5, ChS8, ChF1, ChF2, ChF5 and ChF9; then ChS6, ChS7 and ChF4. The latest to flowering was ChF6.
The period between C and H stades was 35-63 days long. The shortest noted for three Chemlali self pollination descendants (ChS1, ChS3, and ChS5). It was during generally between 42 days (ChF2, ChF5, ChF6, ChF7, ChF8, ChF9, ChS2, ChS6 and ChS7) and 49 days (ChF1, ChF4, ChS4, ChS8 and ChS9). Only ChF3 noted a C-H period during 63 days long.

To check for dependency of phonological stages from temperature and rainfall, meteorological data was collected during the study period. As described by figure 1, we can note that the bud break took place since temperature conditions were favorable up to last ten day of March associated with a general increase of temperature. Similar for the full bloom which started generally after 24 April with a favorable temperature around 25°C.

From the graphical representation of meteorological date, we can note also the concordance of

both phonological stage and rainfall. In fact, it was registered a general anticipation of bud break and full bloom according the rainfall suggesting the dependence of the onset of these phonological stages and satisfaction of water needs of the tree.

Table 2: Timing of phonological stages of 18 olive seedlings obtained through self and free pollination of Chemlali

	27-02	06-03	13-03	20-03	27-03	03-04	10-04	17-04	24-04	01-05	08-05	15-05	22-05	29-05
ChF3	B	C	D	E	F	F1	F1	F1	F1	G	H	I	I1	I1
ChS4	A	B	B	C	D	E	E	F	F1	G	H	I	I1	I1
ChF7	A	A	B	B	C	D	E	E	F1	G	H	I	I1	I1
ChF8	A	A	A	B	C	D	D	E	F1	G	H	I	I1	I1
ChS9	A	A	A	B	C	D	D	E	F1	G	H	H	I	I1
ChF1*	A	A	A	B	C	C	D	E	F	F1	G	H	I	I1
ChF2	A	A	A	B	B	C	D	D	E	F1	G	H	I	I1
ChF5	A	A	A	B	B	C	C	D	E	F1	G	H	I	I1
ChS2*	A	A	A	B	B	C	C	D	E	F1	G	H	I	I1
ChF9	A	A	A	A	B	C	C	D	E	F1	G	H	I	I1
ChS8*	A	A	A	A	B	C	D	E	F	F1	G	H	H	I
ChS1	A	A	A	A	B	B	C	D	E	F1	G	H	I	I1
ChS3*	A	A	A	A	B	B	C	D	E	F1	G	H	I	I1
ChS5*	A	A	A	A	A	B	C	D	E	F1	G	H	I	I1
ChF4*	A	A	A	A	B	B	C	D	E	F	F1	F1	G	H
ChS6	A	A	A	A	A	B	C	D	E	F	F1	G	H	I
ChS7*	A	A	A	A	A	B	C	D	E	F	F1	G	H	I
ChF6*	A	A	A	A	A	A	B	C	D	E	F	F1	G	H

ChF (Chemlali free pollination), ChS (Chemlali self pollination), * (descendants preselected for their percentage of oil and acid composition)

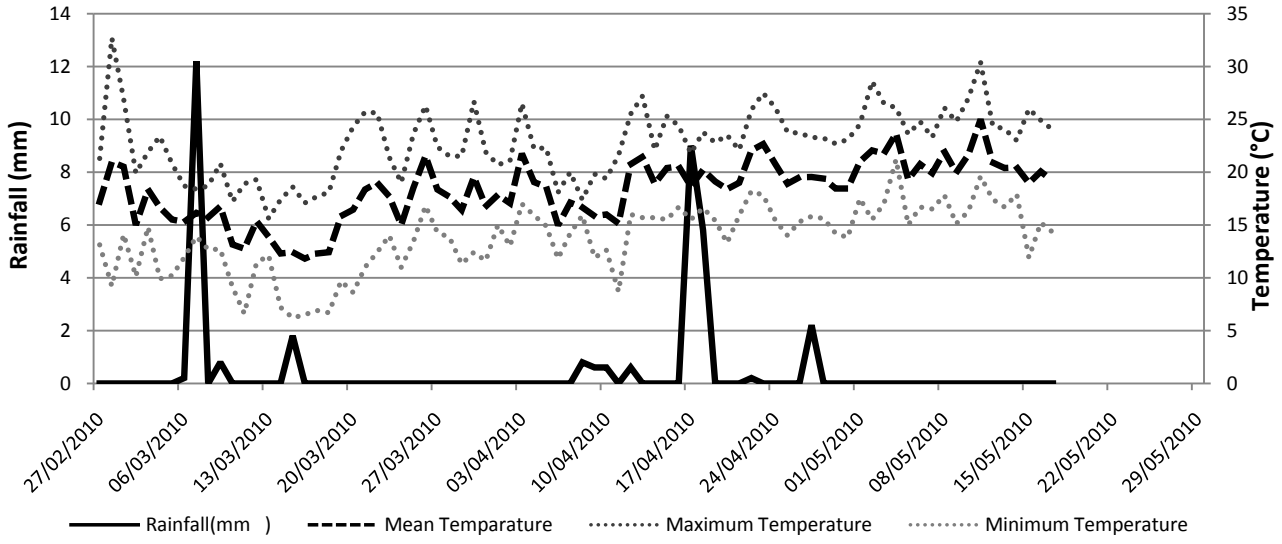

Fig 1: Temperature and rainfall conditions throughout the study period

4. DISCUSSION

A certain degree of morphological variability was found out in flowers and inflorescences among the descendants under study for both types of pollination. These differences were due to genetic variation since the variability recorded did not include an environmental component (same environmental conditions). This variability was as large or even slightly larger than previously observed in olive cultivar collection [8] or in clones of olive variety Picholine Maroccan [9]. It is practically similar to that obtained from cross Leccino*Konservolia descendnts [10].

[11] showed that the ovary abortion is a biological phenomenon very common in the olive tree which is one of the determining parameters of production; the percentage of perfect flowers informs on the degree of fertility of flowers for each descendant. Over studied seedlings, five of them presented an important fertility as the percentages of perfect flowers were generally above 80%. Particularly, the descendant ChS5, which was preselected previously for its oil composition, presented the highest percentage of perfect flowers (95%).

Gradual phonological stages were observed for the studied descendants. This variability can be attribued to the varying requirement of descendants in terms of temperature and cumulative rainfall as suggested by [12]. It can provide a reliable indication of future geographic vocation (more adapted to coastal or continental regions) and agronomic techniques (timing irrigation).

On the other hand, the study of the kinetics of floral phonology and timing of flowering was important to search for possible synchronization and overlapping of flowering between descendants [13] showing therefore for possible cross pollination considered as a tool for improving production [14].

Thus, the present preliminary contribution on morphophenological study of Chemlali olive descendants provides information on potential and behavior of new genotypes with promising performances. However, further investigation of floral biology, including other traits as the compatibility and fruit set will be carried out in addition to present observations for many years. These additional information's, together with the data on the oil performance, are necessary prior to any release of selection.

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