Study of the behavior of cultivars from a world collection of olive (*Olea* spp.) in Morocco

El Oualkadi A[1], Boulouha B[2] and Sikaoui L[3]

[1]Institut National of Agronomic Reserch, Tangier, Morocco.
[2]Consultant; Specialist fruit trees (olive growing), Rabat, Morocco
[3]Institut National of Agronomic Research, Marrakesh, Morocco.
Corresponding author. E-mail: ai.oualkadi@gmail.com

***Abstract*— *In Marrakech (Morocco), a world collection of the genetic resources of the olive-tree was established. This collection currently contains 600 cultivars of various origins. However, work of characterization of these cultivars remains very limited. The objective of this study was to emphasize these genetic resources through their agronomic characterization. We studied certain agronomic characters on some of the most productive cultivars during the 4 years of production 2007-2008-2009 and 2010. Fifteen cultivars originating in various countries that show a cumulated average production higher than 20Kg were then selected for studies of behavior namely: strength, floral biology and the content of oil. The study of vigor of all cultivars showed that Alameno de Marchene, Haouzia, Manzanilla de Sevilla, and Sevillano de Jumilla are most vigorous whereas the cultivars Acebuchera and Blanqueta are the least vigorous and could be used for a system of high density. Analysis of floral phenology of the 15 cultivars revealed overlapping between the majorities of them. This result will contribute to the determination of the adequate pollination for each cultivar. The analysis of the index of compatibility showed that four cultivars (Azeitoneira, Koroneiki, Amargoso and Acebuchera) are self-fertilizing. This study proposes a base of knowledge for the valorization of the Moroccan genetic resources of olive.*

Keywords*— *Olea europaea spp. vigor, floral biology, pollinic compatibility.

I. INTRODUCTION

The olive-tree is one of the most important fruit in the Mediterranean basin (Zohary and Spiegel-Roy, 1975), the domectication and the diversification of the Mediterranean olive tree was verified by (Besnard et al., 2013). The world production was estimated in 2012 at 3.408.500 tons for the olive oil and 2.526.000 tons of olives of table (COI, 2013). In Morocco, the olive tree it’s characterized with agronomic and adaptive characteristics likely higher than those of other traditional varieties (use of fruit and oil, vigor, phenotypic plasticity...). The result of clonal selection in INRA, two varieties have been registered in the official catalog (Haouzia and Menara) and are currently massively propagated within the program "Green Morocco" (Khadari et al., 2016). In a parallel to the dominance of the variety Picholine Moroccan, an important diversity of genotypes cultivated locally was potentially recoverable (Khadari et al., 2008; El Bakkali et al., 2013). Until now, the INRA Morocco has not a representative collection of the local genetic diversity of all the traditional agrosystems (Khadari et al., 2008). The only ones of olive trees stemming from prospecting in the regions of Marrakech, Meknes and Taounate are in collection in the INRA (centers of Marrakesh and Meknes) and represent only a part of the existing diversity (Khadari et al., 2008 ; El Bakkali, 2013). In the Word, in spite of high initial varietal diversity, a recent tendency towards the establishment of the modern orchards based on the majority of the productive cultivars leads to the high erosion of this genetic material. Several collections of genetic material of olive-tree were create at the national and regional level to control the genetic resources of olive-tree ex-situ; to required, preserve and use them in certain programs of improvement (El Bakkali et al., 2013; Bartolini, 2008). The first attempt to preserve and characterize the most important cultivars of all the olive-growing countries led to the creation of the World Bank of germoplasm of olive-tree in Cordoue, Spain (OWGB Cordoba). More recently, a second international bank of cultivars of olive-tree was installed with the experimental collection of Tessaoute (Marrakech) in 2003. The world collection of Tassaout was an important genetic reserve of the resources of the olive-tree in Morocco. The characterization of these resources constitutes a paramount study in any program of improvement and conservation. Recently, International Olive Oil Council (IOC; Caballero et al., 2006) proposed a system of classification to standardize the descriptors of olive-tree in World (Ganino et al., 2006). The list constitute an indentity card containing of the data passport of the cultivar (origin, zone of origin and distribution), of each the morphological characters, and the agronomic and gustatory criteria. The objectif of this present study was the characterization and the conservation of the genetic resources of olive-tree present in world collection of olive tree in Tassaout, Morocco, in order to have a data bank on the most powerful cultivars in the objective to use them in a program of genetic improvement.

II. MATERIAL AND METHODS

15 cultivars were studied among the 600 cultivars present in the world collection of the olive-tree; these cultivars were selected on the basis of their production cumulated during the first 4 years of production (Table 1). Each cultivar was represented by four trees of olive the moste productive. Those are laid out with a spacing of 7m X 4m, a density of plantation of 357 feet per hectare. The olive tree was irrigated.

Evaluation of vigor

The vigor was studied on the four trees of each selected cultivar. It was expressed by the following parameters:

- Section of the trunk (ST) in cm^2 $ST= P2/4\pi$

P= diameter of trunk

- Volume of foliation (VF) in m^3 $VF= 2/3 \pi r2 H= 2/3 \pi D2/4H= 0.5236*(D)2*H$ D= average diameter = (D1+D2)/2

r= a for circular orbits

H= tree height

- Productive Area (SF) in m^2 $SF= 2 \pi r H= \pi. D.H$

D= average diameter = (D1+D2)/2

r= a for circular orbits

H= tree height

Phenological stages

Floral phenology consists in studying the stage of the race of the phenomenon of flowering (beginning flowering, full flowering and fine flowering), according to the Colbrant (1974).

Floral biology

The following parameters were mesured: the floral phenology, rate of flowering, morphology of the floral bunch, rate of fruit set and fruiting rate.

In the second time, we calculated the class of self compatibility which is the ratio of the number of fruits per inflorescence in self pollination by the number of fruits obtained in free pollination (Zapata and Arroyo, 1978). The content of oil of each cultivar was estimated by the method NMR (Nuclear Magnetic Resonance at base Resolution).

The analysis of the variance was carried out by software SPSS ® version 20.0. Before the analysis, the results which are in the form of percentage were standardized by the angular transformation using the following formula Y= 2 x Arcsin$\sqrt{x/n}$ is defined as the inverse sine function of x when $-1 \leq x \leq 1$; where x and n are used to determine the rates

III. RESULT AND DISCUSSIONS

Tree vigor

The parameters of vigor were calculated for each cultivar, the results are presented in table 2. The average section of the trunk varies from 38 to 110 cm^2 with a median value of 80 cm^2 (table 2). The analysis of the variance shows that the section of the trunk of the trees varies very highly significant between the studied cultivars ($P< 0,001$). The multiple comparisons of the averages of the section of the trunk according to the method of Newman-Keuls classify these 15 cultivars in 4 homogeneous groups. It is noticed that the group having the section of the weakest trunk was formed by the cultivar Sebatera with 38 cm², whereas the cultivar Alameno de Montilla it represents with only the group having the higher section with 110 cm^2 (table 2).

The height of the trees varies between 2 m and 3,7 m with a median value of 3 m (table 2). The analysis of the variance showed that this character fluctuates very highly significant between these cultivars ($P< 0,001$). The Newman-Keuls test gathers these 15 cultivars in seven homogeneous groups. The cultivar espangole Alameno de Montilla was differentiate by the highest value (3,7 m) followed by the cultivar Haouzia also presents high value, this result indicates this national cultivar was strongly vigorous and confirms the result obtained by other work (Boulouha, 2006; Hadiddou et al., 2013).

The area of foliation varies from 6 to 19 m^2 with a median value of 15 m^2. The analysis of the variance showed the existence of a difference very highly significant between the cultivars for this character ($P< 0,001$). The test of Newman-Keuls made it possible to distinguish 7 overlapping homogeneous groups. The cultivar Alameno de Montilla has larger area of foliation (19 m^2) and does not differ significantly with the cultivars Galega vulgar, Sevillano de Jumilla and Manzanilla of sevilla which present a value of 17 m^2. The cultivar Blanqueta has a weak area of foliation (6 m^2).

The volume of foliation of the 17 cultivars varies from 2 to 9 m^3 with an average volume of 5 m^3 (table 1). The analysis of the variance revealed a highly significant difference between the cultivars tested ($P<0,001$). The Newman-Keuls test revealed two homogeneous groups including three. The group of weak foliation was formed by the majority of them. The highest values of foliation are noted at the cultivars Manzanilla de Sevilla and Haouzia with 9 m^3 (table 2).

The results of the vigor of these 15 cultivars under the conditions of the area of Haouz, release a great variability between the cultivars tested for the four parameters studied, with significant area of foliation, the section of the trunk, the total height and the volume of foliation of the tree. This variation observed at the seventh year of

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plantation was allotted mainly to the effect of the cultivar. Indeed, work of Del Rio et al. (2006) confirmed the cultivar has responsibility for the total variation observed for the volume of foliation, the productive area and the section of the trunk of the trees with 79%, 82% and 73% respectively. The pedoclimatic conditions apply an effect on the productive expression of the cultivars and the characteristics of the product. It is very rare to see a cultivar expressing the same productive performances in environments different from its origin. In the same way, other factors can affect the development of olive-tree since the moment of its plantation, in particular the medium and in particular the quality of the ground (Gálvez et al., 2004; Hadiddou et al., 2013) and the understock (Loussert and Brousse, 1978). These results relative to these four indices for these cultivars show that the cultivars Alameno de Marchene, Haouzia, Manzanilla de Sevilla, and Sevillano de Jumilla are most vigorous. For the cultivar Haouzia this result was already confirmed by other studies (Boulouha, 2006). However, the cultivars Manzanilla de Sevilla and Blanqueta are not very vigorous and adapt easily to the culture in intensive plantations in their countries of origins (IOC, 2007). The cultivar Koroneiki has an average vigor, which confirms the result of the study of Lavee (2002). Consequently, this cultivar was largely used in super intensive beside Arbequina and Arbosana (Vossen, 2007).

The floral biology of the 15 cultivars of olive-tree studied

Floral phenology

Figure 1 shows the chronology of phenological steps (F), (F1) and (G), at the 15 cultivars studied during the period 2010-2011. The majority of these cultivars show overlappings of the times of flowering. This makes it possible to classify these cultivars in three types:

- Cultivars with early flowering: Koroneiki, Blanqueta, Sevillano de Jumilla, Alameno de Marchene, Negrinha, Haouzia, Azeitonera, Amargoso and Changlot Real.
- Cultivars of season: Galega vulgar, Sebatera, Alameno de Montilla, Fulla of salce, and Manzanilla de Sevilla.
- Cultivar with late flowering: Acebuchera

The time of flowering was variable from one cultivar to another. Indeed, the study of the distribution of the times of flowering shows that the cultivars Koroneiki and Sevillano de Jumilla the duration of flowering was extended (30 days). As for the cultivars Sebatera, Alameno de Mentilla, Azeitoneira and Acebuchera it was shorter (14 days). The koronieki cultivar starts production early in its country of origin (IOC, 2007). The cultivar Galega vulgar start production early in its country of origin and its time of flowering was middling. But the cultivar Manzanilla de Sevilla early starts production its time of flowering is middling (IOC, 2007). The cultivar Changlot Real stare at one time of average flowering whereas the Acebuchera cultivar shows one time of tradive flowering in Spain (IOC, 2007). A comparative study of the times of flowering during two crop years at 5 cultivars (Arbequine, Picholine Languedoc, Picholine Marocaine, Manzanille and Sourani) showed the fluctuations of the dates of flowering from one year to another. This is especially related to the temperatures of Mars and April (Griggs et al., 1975; Nait Taheen, 1993). Several other authors showed that the low temperatures stimulate the formation of the inflorescences (Hartmann et Whisler 1975) whereas the high temperature inhibits their appearance (Ouksili, 1983). The nutritional conditions, in particular the nitrogen, potassium and phosphorus support flowering (Tsikalas and Parchaladis, 1980). However, their availability for the metabolism of the tree depends closely on the hydrous food.

Rate of flowering

Floral biology is an aspect important to study because the processes of floral induction, flowering and fructification are determining in the realization of the production. Although the introduced cultivars were characterized in their countries of origin, the environmental conditions of the collection can have an important influence on their behaviors. The results obtained for the 15 studied cultivars are represented in figure 2. The rate of flowering varies from 11% at the cultivar Acebuchera with 98% noted at the cultivar Sevillano de Jumilla.

The analysis of the variance show the differences very highly significant between the cultivars ($P<0.001$). The multiple comparisons of the averages according to the method of Newmann and Keuls release seven homogeneous groups. The study of the rate of flowering at different the cultivars showed a variation of this parameter at these different cultivars. In the same way, the studies showed the rate of flowering varies from one year to another for same the cultivar, and from the significant differences were obtained during two years of studies for same the cultivars. These differences are generally related to the variations of the climatic conditions and physiological of the old tree to another. For example, at the cultivar Haouzia, the rate of flowering (62%) confirms the stability of this cultivar as the same result was got by Nait Taheen (1993) studied with the collection Menara of Marrakech. The work completed in 1993 by Nait Taheen, showed there exists a positive and significant correlation between the rates of flowering and the extent of the winter cold. The same observations were reported by Hartmann and Prolingis (1975).

Morphology of the floral bunch

Median number of flowers per inflorescence

The results obtained for this parameter are presented in figure 3. It is noted that the number of flowers per inflorescence varies between 9 at the cultivar Changlot Real and 30 at the cultivar Sevillano de Jumilla. The number of flowers per inflorescence varies significantly according to the cultivar ($p < 0.001$). The multiple comparison of average shows the existence of ten homogeneous groups which overlap between them. The first group of cultivars with median number of flower per the weakest bunch (less than 12) it was the cultivar Changlot Real. As for the group having the median number of flower per the highest bunch (30) was formed by the cultivar Sevillano de Jumilla.

Average number of hermaphrodite flowers per inflorescence

The majority of the cultivars have a rate of hermaphrodite flowers superior to 50% (figure 4). For the cultivar Sebatera and Haouzia the rate of hermaphrodite flowers was 16 and 18% respectively. While the two cultivars Amargoso and Changlot Real have a very high rate of 95 and 93% respectively. The analysis of the variance shows the existence of a difference very highly significant between the cultivars ($p < 0.001$). The multiple comparison of average made it possible to groups the cultivars in 4 homogeneous groups.

The median number of flower per inflorescence was variable at different cultivars studied. However, for the studies realized on others cultivars showed that there are no significant differences between the cultivars compared to the number of flower per inflorescence. This parameter was regarded for a cultivar given as a stable character (Moundi, 1974). However, our results are in agreement with several authors on others cultivars (Lavee, 1996; Lavee et al., 2002).

Many studies showed that the median number of flowers hermaphrodites varies according to the years of production. This variation was related to the action of the minimal temperatures reigning for the period separating the stage from debourrement from the buds of the stage beginning from flowering, lasting which occur the differentiation and the complete development of the flowers (Spiegel-Roy, 1965; Badr and Hartmann, 1971). This character can be also influenced by the lack of water especially during the period separating floral differentiation until the complete evolution from the flowers (Hartmann and Panestos, 1961).

Rate of fruit set

A counting of the inflorescences of each fruit-bearing branch was carried out. At the time of the fall of the petals, the sachets are removed and with the fruit set, the number of tied fruits was given. The results of the rates of fruit set obtained for each mode of pollination are illustrated by figure 5. The rates of fruit set, in the event of self pollination, are understood between 1% and 99% fruits tied by bunch. Whereas in the event of free pollination, these rates are understood between 42% and 100% fruits tied by bunches. By comparison the rates of fruit set obtained in free pollination; the rates of fruit set in self pollination appear weak at the cultivars Sebatera (1%), Manzanilla de Sevilla (3%), and Haouzia (8%). The other cultivars such as Alameno de Marchene, Galega vulgar, Koroneiki and Amargoso have rates of higher fruit set in free mode of pollination, whereas the cultivars Sevillano de Jumilla and Changlot Real show rates of fruit set in self pollination similar to those of free pollination (figure. 5).

The analysis of the variance show a highly significant differences between the cultivars and the mode in pollination on the fruit set with respectively (P=0,004) and (P=0,006) for the first and the second factor. Thus, the multiple analyses of the averages reveal 5 homogeneous groups. The first group was formed by cultivars for which average of fruit set was very different between the self pollination and free pollination; it acts of the cultivars of the (A) group: Sabatera. The 2nd group (c) contains cultivars which have similar average rates of fruit set in free pollination that in self pollination, they are the cultivars Sevillano of jumilla and Changlot Real. Between the two groups (a and c) was cultivars whose variation of the average rate of fruit set was at least weak between the two modes of pollination, it acts of the group (ab) with cultivars Alameno de Marchene, Galega vulgar, Haouzia, Negrinha and Manzanilla de Sevilla. Whereas the group (abc) with the cultivars Azeitoneira, Amargoso, Acebuchera, Blanqueta, Fulla of salce and Alameno de Montilla.

Fruiting rate

The fruiting rate obtained was between 0 and 92% in self pollination and of 5% and 98% in free pollination. These results represent an increase in fruiting rate into free mode of pollination compared to the self pollination (figure 6). It should be noted also that in self pollination, the cultivars Koroneiki, Alameno de Marchene and Sevillano de Jumilla are characterized by a high fruiting rate (92%, 44% and 40% respectively).

A great variability was observed between the cultivars and the two modes pollination (self pollination and free pollination) for the fruiting rate with (P=0,002) as well for the first and the second factor. The multiple analysis of average revealed 3 homogeneous groups. The group of the cultivars with the similar middling fruiting rate in self pollination and in free pollination, it was about the (A) group with cultivars Acebuchera, Amargoso and Azeitoneira and Koroneiki. The 2nd group (c) contains cultivars with a middling fruiting rate very different between the two modes from pollination; it acts of only one cultivar Sebatera. The other group (b) contains cultivars whose variation of the middling fruiting rate was at least weak between the two modes of pollination for each cultivar.

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The majority of the cultivars showed a positive response with free pollination. This positive response appears by an increase very highly significant in rate of fruit set and fruiting rate. The lower level for the fruiting rate, met primarily in the event of self pollination, could be due on a level lower of fecondation and a rejection of its pollen, and in the adverse conditions create inside the isolation. This explains why we met small fruits probably parthenocarpic which develop in great quantity under the conditions of poor pollination and especially when the temperature exceeds 30° C (Lavee, 1996).

These results reveal the cultivars which gave the highest rates of fruit set also generated important rates of fall. Thus, more one tree was charged out of fruit, more the fall of the fruits was important. This phenomenon of nutritive competition between fruits was reported by several authors (Suarez et al.; 1984; Rallo et al., 1981; Rallo and Fernandez-Escobar, 1985; Cuevas and Rallo, 1990). In this case the tree tends to regularize its physiological balance in order to obtain fruits of good gauge. The climate was also another factor to be considered, insofar as the high temperatures advance the fall of the fruits at many cultivars of olive-tree (Rallo et al., 1990). These climatic factors are in our case accentuated by the artificial conditions creating by the conditions of paper sachets.

Self compatibility index

The calculation of the self compatibility index at the 15 cultivars studied makes it possible to classify them in 3 groups:

- Strongly self-compatible cultivars: Azeitoneira, Koroneiki, Amargoso and Acebuchera.
- Partially self-compatible cultivars: Sevillano de Jumilla, and Allameno de Marchene, Galera vulgar,
- Strongly self-incompatible cultivars: Sebatera, Manzanilla of sevilla, Changlot Real, Blanqueta, Haouzia, Alameno de Montilla, Fulla de Salce and Neghinha.

The Studies of behavior of certain cultivars showed the cultivar Picholine Languedoc was highly self-compatible, the cultivar Sourani presents a satisfactory self-fertility. However, the cultivars Picholine Marocain, Manzanille and Arbequine can be regarded as partially self-compatible.

In recent study by Breton et al. (2014; 2016) showed that in the olive tree, the system of reproduction, completely particular compared with the other fruit species, leads at present, most of the orchards to be in money chronic production due to the lack of pollinators.

Other studies showed the same cultivars behave differently with the test of compatibility. Thus, the cultivars considered in this study as self-compatible, compatible or self-incompatible in their countries of origin. The study made by Aoubid in 2009 showed that the cultivar Amellau was self-compatible whereas the same cultivar was noted self-incompatible according to Moutier et al. (2004). The same studies shown as the cultivars Italians Rosino, Santa Caterina and Rossello which are considered, in their country like self-incompatible cultivars (Cimato et al., 1993; Cimato et al., 2001), are self-compatible in the world collection of Tassaout (Aoubid, 2009). The cultivars such as Sassarese, Morchiaio and Gremignolo di Bolgheri kept their degree of compatibility the same one as that obtained by the other authors (Androlakis and Loupassaki, 1990; Cimato et al., 1993; Lavee, 1996; Cimato et al., 2001; Lavee et al., 2002). The cultivar Galega vulgar was slef compatible in its country of origin (IOC, 2007) whereas our study showed the cultivar was partially auto compatible. The cultivar Manzanilla de Sevilla was cultivated without pollinating in Spain (IOC, 2007), pollination seems better in crossed pollination, in the other countries, the use of pollinating was essential this in conformity with our results.

The content of oil

The content of oil of olives of the cultivars was one of the most important parameters. We determined the content of oil of the 15 most productive cultivars during the 4 years of production. The results are indicated in figure 7. All the cultivars present a content of higher oil or equalizes to 40%. The cultivar Koroneiki presents the content of the highest oil (56% MS) whereas the cultivar Manzanilla de Sevilla presents the lowest value (40% MS).

The Koronéiki cultivar was the principal cultivar of oil of Greece according to the IOC (Catalogue of the cultivars), its output oils some in its country of origin very high, and it was very appreciated by its acid content oleic very high. This result shows this cultivar always keeps these large values for the production of olive oil under the Moroccan environmental conditions. The cultivar Galega vulgar was very appreciates by its content of oil in its country of origin, it is used primarily for the oil extraction (IOC, 2007). The cultivar Manzanilla de Sevilla shows a content of stable average oil of good quality in its country of origin, this result similar that which obtained whereas the cultivar Changlot Real shows a high content of oil quality in Spain (IOC, 2007). The Blanqueta cultivar presents a content of high oil soft and fruity of low stability was good quality in its country (IOC, 2007). A recent study in Morocco showed that the contents in oleic acid for Haouzia (76,1 %), Dahbia (75,3 %) and Menara (75,2 %) were higher than that of Arbéquine (66,2 %) (Mahhou et al., 2014).

IV. CONCLUSION

This works could prove the perfermence of the same cultivars of the world collection of olive tree in Marrakech (Morocco), it acts on the cultivars with same characteristics; this enables us to think this material deserves being proposed to propagate by the agricultures in the region. This cultivars contrains same important characteristics and can be utilized in the program of genetic improvement. In perspective, these cultivars should multiply in other areas of Morocco, in order to know the differentiation of this cultivars beter the various zones.

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Table.1: The liste of the cultivars selected

Cultivar	Origin	Cumulated average production (2007 to 2010) in Kg
Blanqueta	Spain	36
Fulla de salce	Spain	34
Amargoso	Spain	32
Acebuchera	Spain	29
Haouzia	Morocco	29
Changlot Real	Spain	27
Negrinha	Portugal	26
Alameno de Marchene	Spain	26
Azeitonera, Azeitira	Portugal	23
Galega vulgar	Portugal	23
Sebatera	Spain	22
Sevillano de Jumilla	Spain	21
Koroneiki	Greece	21
Alameno de Montilla	Spain	21
Manzanilla de Sevilla	Spain	21

Table.2: The vigor of 15 cultivars selected

Cultivar	Average of the section of the Trunk (cm^2)	Average total height (cm)	Average of the areaof foliation en m^2	Average of volume of foliation en m^3
Acebuchera	$67^{ab} \pm 13$	$235^{ab} \pm 12$	$9^{ab} \pm 1.8$	$3^{a} \pm 0.8$
Alameno de Marchene	$80^{bc} \pm 6$	$369^{e} \pm 13$	$19^{ef} \pm 1$	$8^{ab} \pm 1$
Alameno de Montilla	$110^{c} \pm 14$	$344^{de} \pm 21$	$17^{def} \pm 3$	$6^{a} \pm 1$
Amargoso	$70^{ab} \pm 15$	$243^{ab} \pm 15$	$12^{bc} \pm 1.6$	$5^{a} \pm 0.6$
Azeitonera	$66^{ab} \pm 10$	$308^{cd} \pm 14$	$16^{cde} \pm 1.7$	$5^{a} \pm 0.9$
Blanqueta	$53^{ab} \pm 10$	$200^{a} \pm 16$	$6^{a} \pm 0.7$	$2^{a} \pm 0.3$
Changlot Real	$68^{ab} \pm 15$	$250^{b} \pm 14$	$12^{bc} \pm 1.9$	$5^{a} \pm 1.04$
Fulla de Salce	$56^{ab} \pm 8$	$243^{ab} \pm 9$	$12^{bc} \pm 1$	$5^{a} \pm 0.6$
Galega vulgar	$62^{ab} \pm 5$	$341^{de} \pm 21$	$18^{ef} \pm 1$	$7^{a} \pm 1$
Haouzia	$88b^{c} \pm 16$	$351^{de} \pm 13$	$21^{ef} \pm 0.8$	$9^{ab} \pm 0.9$
Koroneiki	$62^{ab} \pm 5$	$261^{bc} \pm 18$	$13b^{cd} \pm 1.8$	$5^{a} \pm 0.8$
Manzanilla de Sevilla	$83^{bc} \pm 18$	$350^{de} \pm 6$	$18^{ef} \pm 2$	$9^{ab} \pm 1$
Negrinha	$66^{ab} \pm 12$	$329^{de} \pm 17$	$18^{def} \pm 2.4$	$6^{a} \pm 1.3$
Sebatera	$38^{a} \pm 16$	$332^{de} \pm 18$	$13^{bcd} \pm 2$	$5^{a} \pm 1$
Sevillano de Jumilla	$80^{bc} \pm 15$	$348^{de} \pm 21$	$18^{ef} \pm 1$	$8^{a} \pm 1$
Valeur moyenne	80 ± 3.9	297 ± 4	15 ± 0.1	5 ± 0.1
CV (%)	4.8	134	0.66	2

The cultivars which present the same letters do not differ significantly (P>0.05). Test Newmann-Keuls

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Date of appearance, lasted in phenologic days and spreading out of the three stages Beginning of flowering (F), Full flowering (F1) and Fine flowering (G) at the 15 cultivars studied for the partner 2010-2011

F= Beginning of flowering
F1= Full flowering
G= Fine flowering

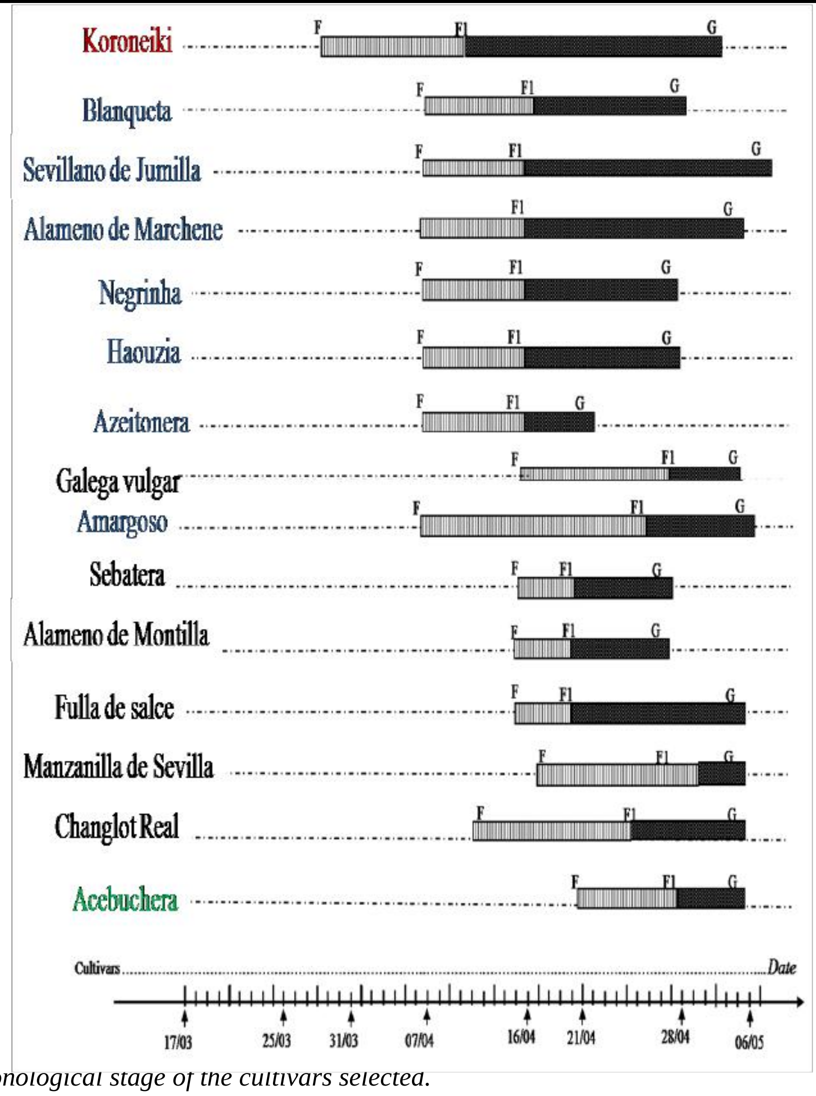

Fig. 1: Phonological stage of the cultivars selected.

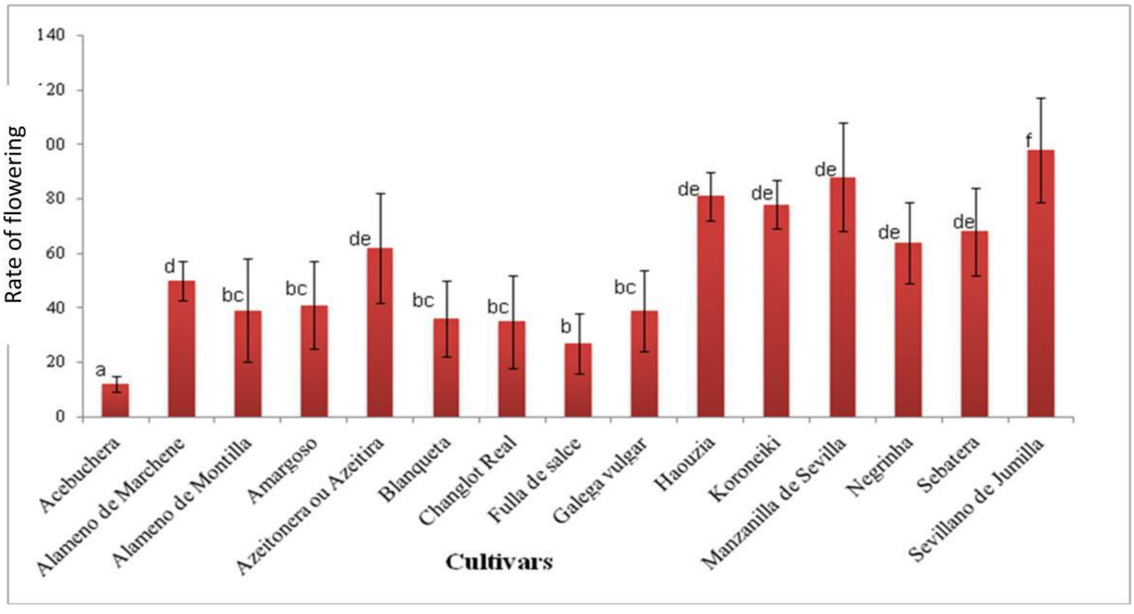

Fig. 2: Rate of flowering for the cultivars selected.
The cultivars which present the same letters do not differ significantly (P>0.05). Test Newmann-Keuls

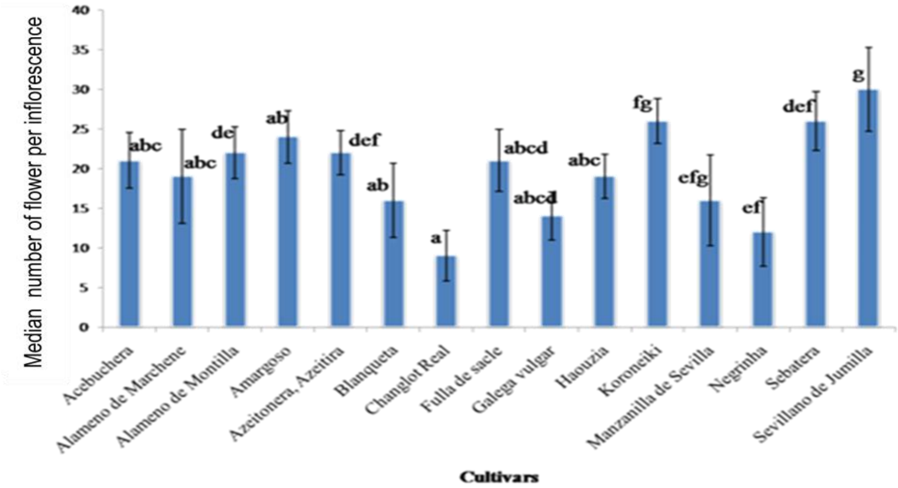

Fig.3: Median number of flower per inflorescence for the cultivars selected.
The cultivars which present the same letters do not differ significantly (P>0.05). Test Newmann-Keuls

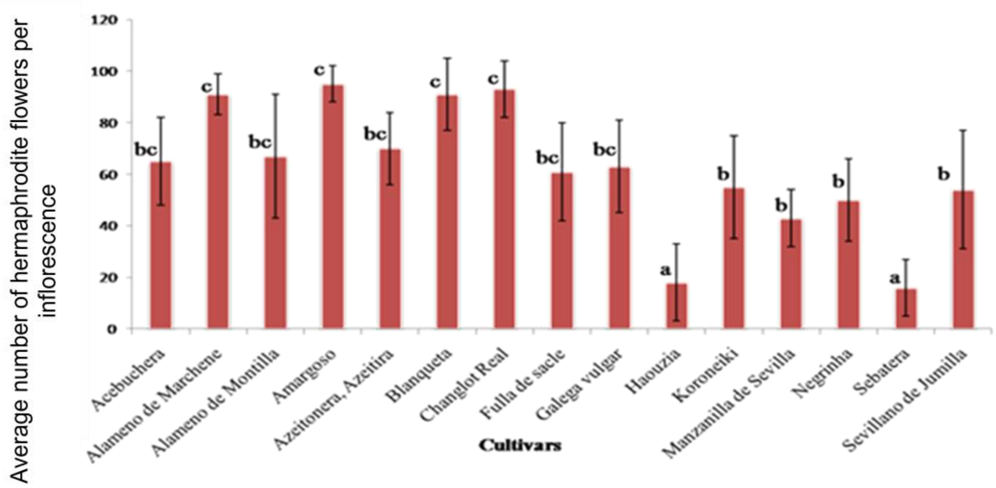

Fig.4: Median number of hermaphrodite's flowers perinflorescence for the cultivars selected
The cultivars which present the same letters do not differ significantly (P>0.05). Test Newmann-Keuls

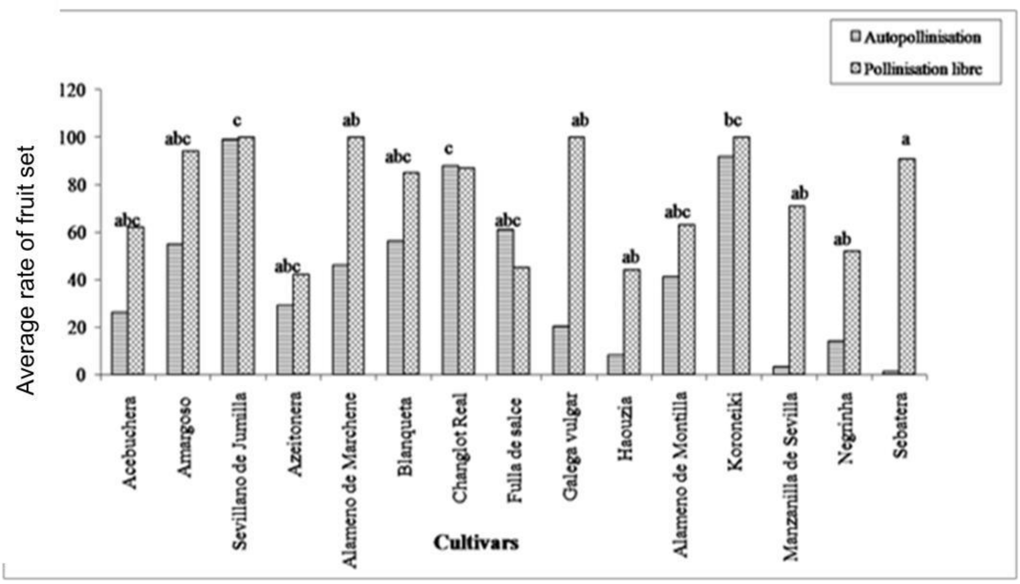

Fig. 5: Average rate of fruit set for the cultivars selected
The cultivars which present the same letters do not differ significantly (P>0.05). Test Newmann-Keuls

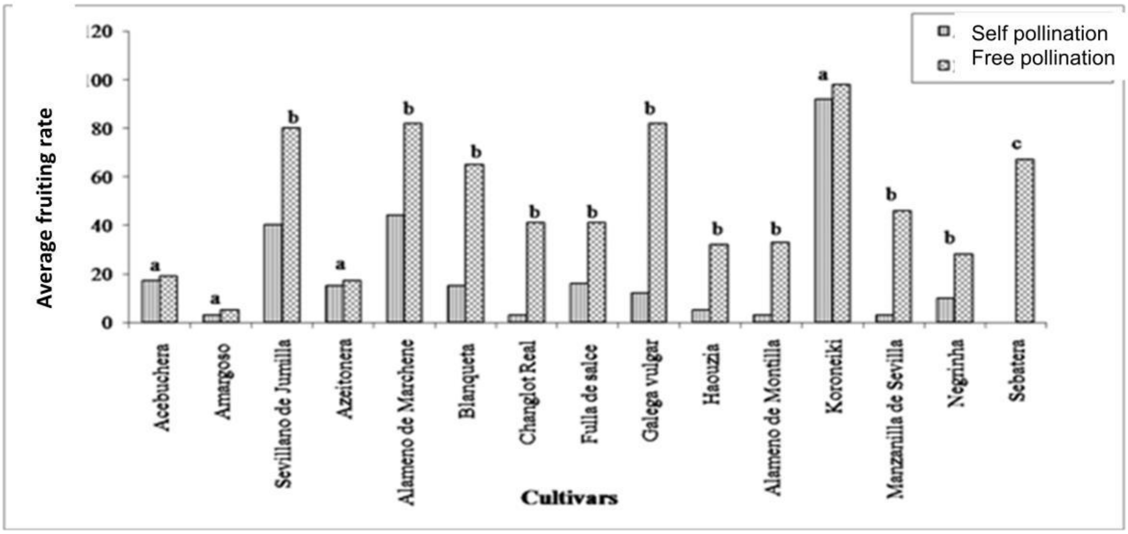

Fig. 6: Average fruiting rate obtained at the 15 studied cultivars.
The cultivars which present the same letters do not differ significantly (P>0.05). Test Newmann-Keuls

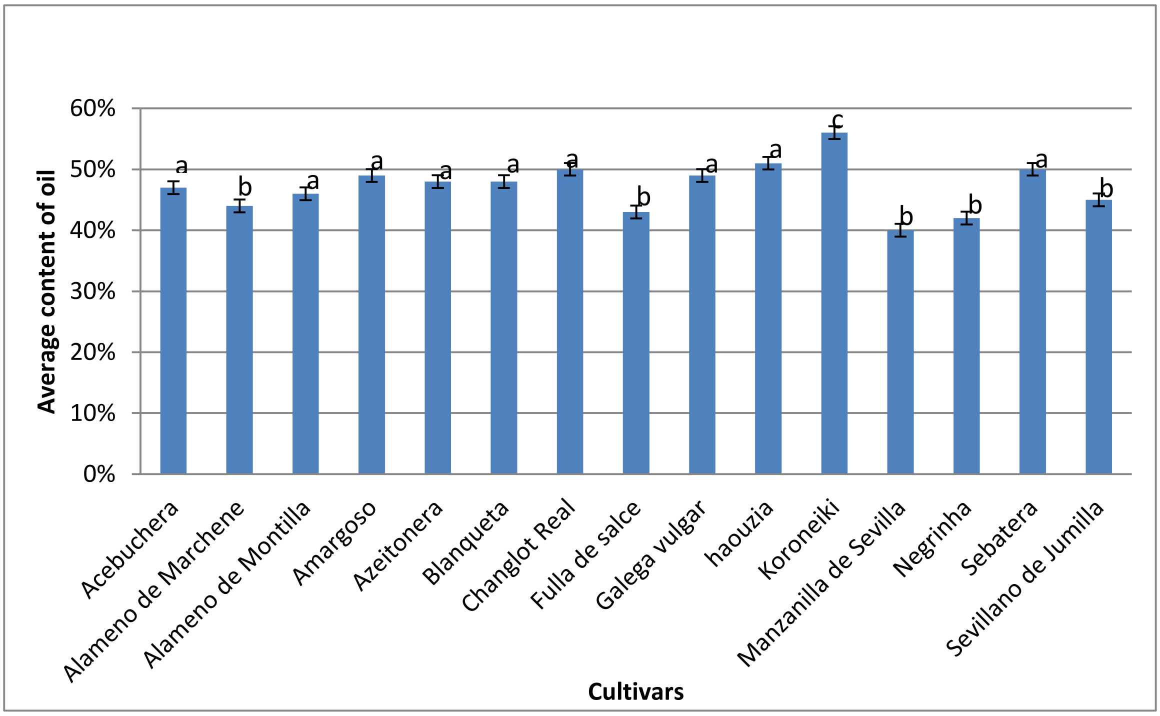

Fig. 7: Content of oil for the cultivars selected
The cultivars which present the same letters do not differ significantly (P>0.05). Test Newmann-Keuls