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The Effect of Environmental Conditions on Phenological Characteristics in Native Olive Genotypes (Oleaeuropaea L.) of Ilamprovince

Akbar Esmaeili, Azar Seyde
Ilam Agricultural and Natural Resource Research and education center P.o.Box. 69317-73835. Ilam, Iran.

ABSTRACT—In order to investigate the effect of environmental conditions on phenological characteristics of native olive genotypes in Ilam, 46 genotypes in 9 regions of Ilam were studied for two years. The data variance analysis showed significant difference among genotypes in different regions for all traits. The results showed that there is significant difference among genotypes in different regions for all traits. Also, the inoculated flower in both open and closed states is determined by isolating the flower clusters using jaconet and the results shown in these traits were significant. The results showed that the maximum amount of complete flowers was related to the genotype Pakel Grub 4 (PG4), the maximum time to complete buds from the emergence of inflorescences to the fall of petals and latest departure time of inflorescences was related to the genotype of Agricultural Jihad Organization (SK8). The highest amount of inoculated flower in the open and close conditions was recorded for the genotype Siab Malikshahi 2 (Sbm2). The longest inflorescence was related to the genotype Ganje 4 (GM4) and the highest number of flowers per inflorescence and the inflorescences per branch were respectively for the genotypes Faraj Saleh Abad 8 and 9 (KFS8,9). In general, it seems that factors such as temperature, altitude and growth conditions of genotypes have a significant effect on phenological characteristics.
KEYWORDS: native olive genotype, environmental conditions, phenological characteristics, pollination characteristics

Introduction

Olive or Oleaeuropea L. originates from Oleaceae family, an ancient tree compatible with Mediterranean regions, which has the highest growth and development rate in 30 to 45 degrees' north latitude and altitude of 800 to 1,000 meters above sea level. Plant Genetic Resources as the foundation of researches online breeding are of great importance and their preservation is very important from national and international perspective. In Ilam, there are local and long history olive masses scattered in different forest areas and natural habitats of the province (Ismaili, 2007). This study will examine the effect of environmental conditions on phenological characteristics of these genotypes, pollination and fruit. The percentage of complete and incomplete flowers differs in different olive varieties and this may determine the product of a variety; the complete flowers produce normal and healthy fruits, while the incomplete flowers are not fruit producer (McGregor, 1976). Sometimes the production decreases due to lack of proper inoculation of flowers and finally the fall of flowers and fruits (1.Troncoso *et al*., 1978). High temperature is a limiting factor for the self-sterile flowers (Sadeghi, 2002, Casaraccioet al., 2008, Metheney et al., 1994). It has been reported that flowering, formation and development of the fruit of olive tree is heavily dependent on weather conditions, it has been also reported that low rainfall, high temperatures and low relative humidity reduces the growth of branch and the amount of carbohydrate and finally, reduces the production (Rotondi and Massimiliano, 1994). Low temperature and water stress during the development of pistil increases the pistil abortion rate (Marra et al., 2006, civil, et al., 1994, Rapoport and Martin, 2006). In the flowering season, the rainfall can wash out the pollen and reduce the inoculation and thus remain unfilled kernels. As a result, the production of shadberry fruits (Partnvkarp) will be increased (Tabatabai, 1995, Rapoport and Martin, 2006). Flowers usually have very sensitive organs against climate phenomena, particularly cold, dry wind and cold, rain and fog (Sadeghi, 2003). Flowering period depends on the temperature of the environment, especially flowering in the regions are warm in the evenings is faster and the flowering will be completed during the 3 to 4 days but it may take 2 to 3 weeks in cooler areas (Sadeghi, 2002). Inflorescences in olive have 10 to 35 flowers influenced by factors such as variety, growth, and position of inflorescences on the fruiter branches (Metheneyet al., 1994). It was also shown that high temperatures at flowering season of the Manzanilla olive cause the pollen tube growth in the cream to be incomplete and doesn't reach the egg and finally increase the drop of early fruits. In the spring when the weather is cool, the production of fruit increases and the number of fruits per inflorescence can reach 5 to 7 (Tabatabai, 1995). McGregor stated that most of the olive varieties are self-fertile and some of them are self-sterile and some of them are between these two (McGregor, 1976). Studies have shown that the temperature rise during the spring in recent years in the northern hemisphere, such as Europe and the United States, will put forward the flowering time and starting of growth phases in the olive trees (Hanninen, 1995). Also Osborne et al., (2000) stated that high temperature is effective on the development of flowering and maturation of olive buds and reported that cool temperatures are required in the early season for the development and flowering of olive (Nankely et al., 2000,Sadeghi, 2002). Temperature and proper humidity levels in the soil and variety play

important role in increasing the size of fruit's endocarp (Metheneyet al., 1994). The effect of environmental conditions on phenological characteristics (departure time of inflorescences, opening time of flowers, bloom time, the duration of the flowers, the fall of petals, initial formation of the fruit) will be examined in this study.

Materials and methods

The research was carried out in the regions of Ilam with native genotypes of olive, 46 genotypes in 9 regions of Ilam were selected (Table 6). With the onset of spring, the emergence time of inflorescences, flowering time, the time of maximum flowering, the time of fall of petals and the time of formation of frits were recorded. In each of the selected genotypes, coinciding with the opening of inflorescences, 4 branches with inflorescences were chosen from four trees and then jaconet bags of the size 20 * 30 were selected for each of the branches to cover the branches and determine the percentage off lower inoculated in the closed conditions. 4 branches were also labeled for pollination in open air next to the bagged branches. After the fall of petals and inoculation, the bags were opened to record the pollination. At the same time the buds were swollen by Binocolar, the number of complete flowers for each genotype was determined by selecting 4 branches around the tree. Characteristics such as length of inflorescence, number of inflorescence per branch and number of flowers per inflorescence were recorded for each genotype.
The research was tested in a completely randomized design. The results were analyzed using the software MSTATC and the means comparison were performed using Duncan cross-domain test.

Results and Discussion

The results of variance analysis (Table 1) show that the characteristics number of inflorescence per branch and number of flowers per inflorescence has significant difference among genotypes at 1% level. Table 3 shows the comparison of the mean that the minimum inflorescence per branch is related to the genotype Ban Sarv Chewar 3 (BSCH3) with 13.75and the maximum inflorescence per branch is related to the genotype Kolah Faraj Saleh Abad Hat 9 (KFS9) with 25 inflorescences. The lowest number of flowers per inflorescence is related to the genotype PardehChewar1 (PCH1) with 10 and the highest number of flowers per inflorescence is related to the genotype Kolah Faraj Saleh Abad 8 (KFS8) with 35.5 flowers. According to the results of variance analysis Table, it can be seen that the characteristics of the percentage of flowers inoculated in the open air, the percentage of flowers inoculated in the bag, the length of inflorescence and the percentage of complete flower among genotypes was significant at 1% level. Table 4 for mean comparison showed that the lowest percentage of flowers inoculated in the open air is related to the genotype Kolah Faraj Saleh Abad 4 (KFS4) with 2.75% per cent and the highest percentage of flowers inoculated in the open air is related to the genotype Siab Malikshahi 2 (SBM2) with 26.5%. Genotypes with the highest inoculated flower are Sarv Chewar (BSCH) at an altitude of 1210 meters above sea level and Siab Malikshahi (SBM) at an altitude of 1130 meters above sea level. The lowest percentage of inoculated flower is in the genotype Drag Zarneh (DZ) whose growth was in the rock and under severe drought stress. The lowest percentage of inoculated flower in the closed state pertains to the genotype NargsehSalehabad9 (NS9) with0.75% and the highest percentage of inoculated flower in the closed state pertains to the genotype Siab Malikshahi 2 (SBM2) with25.5%. It seems that the genotypes which are less under water stress over the year have higher inoculated flower either in closed or open state. As the genotypes located in different regions and the lack of arable masses of olive around them, they have been completely isolated and there was no effect on their pollination causing higher inoculation of flowers in the open state and thus the inoculated flower percentage has been recorded the same in both cases in many different genotypes. The shortest inflorescence is related to genotype of Agriculture Organization of Ilam 5 (SKE5) with14.6mm and the maximum length related to the genotype Siab Malikshahi 1 (SBM1) with 42.2mm. The genotypes of Ganjeh Mishkhas and Siab Malekshahi have the longest inflorescence. The lowest rate of complete flower is related to the genotype Pardeh Chewar 2 (PCH2) with 15% and the highest rate is related to the genotype Pakel Grub 4 (PG4) with 69%. The genotypes of Pakel Grub (PG) had higher percentage of complete flower due to their appropriate growing conditions and also being in the garden and using irrigation water sometimes in the growth time. It was shown that the emergence of flower clusters, the opening of flowers, the number of flowers per inflorescence, the percentage of complete flowers, and the percentage of flowers inoculated in open and closed conditions in studied genotypes were variable. It was concluded that the rate of complete flowers prepared for fertilization and fruit production varies in different genotypes so that the genotype PakelGrub 4 (PG4) has the most complete flower. Due to the genetic nature of this property and reports of several researchers, we can put this property as the basis of selecting the superior varieties with desirable characteristics of inoculation and pollination. Phenological condition and the production and inoculation of flowers can be influenced by genotype (Mara et al., 2006, Rapoport and Martin, 2006). In order to determine the phenological characteristics of complete flower, the percentage of pollination in open air and closed conditions were measured and it was found that the percentage of complete flower affects the rate of inoculated flowers in open and close conditions. The high percentage of complete flowers alone couldn’t be considered as a preference of an olive genotype, but the pollination is also very important. The above findings are consistent with the results of Asno Ashariand Gholami (1989). Most of flowers in olive are complete, but in addition to incomplete flowers falling down, complete flowers also fall and aborted on which factors such as environmental factors, nutrition, water stress and competition with other flowers are also effective. When 1 to 2 percent of flowers in a tree become fruit, the tree will have economic burden (Rapoport and Martin, 2006). It was reported

that low temperatures at the growth time of flowers during spring are effective on phenological characteristics (Bignamy et al., 1994, Osborne et al., 2000). In this study it has been indicated that the percentage of complete flowers in the studied genotypes shows a wide range having different percentage of complete flowers even among the genotypes of each mass. High level of flower loss was observed before fruit production that seemed factors such as environmental factors, nutrition, water stress and competition of flowers with each other are effective on the loss of flowers (complete and male) and these changes are due to environmental effects such as temperature, humidity and genotypes. The above findings are consistent with Rapoportand Martin (2006), Osborne et al. (2000), and Bignamiet al (1994). In most genotypes, there was a severe loss after fruit production and growth. According to the findings presented by researchers, it seems that the higher is the percentage of autogamy in an olive variety, the fruit drop is higher. This phenomenon can be attributed to a specific form of incompatibility. Preserving the fruit by the tree is a feature usually seen under cross pollination conditions. A good variety of olive must have appropriate pollination in addition to high level of producing natural and complete flowers and also has the lowest rate of fruit drop. The average number of flowers inoculated in the bag is effective on the percentage of autogamy and cross pollination so that an increase in the number of flowers inoculated in the bag will increase the percentage of autogamy and decrease the percentage of cross pollination. There is a direct relationship between the rate of complete flower and fruit production per tree. Also the rate of autogamy, cross pollination and intermediate pollination of the studied genotypes are different. The above contents are consistent with the results of Metheney and colleagues (1994). Significant difference was observed between genotypes in terms of characteristics such as length of inflorescence, number of flowers per inflorescence, the percentage of flower inoculated in the open and closed air and there were also different levels among the masses of the region. It was shown that environmental effects on these traits are significant, the above findings are consistent with Frey et al (2006). According to Table 5, the recording time of phenological characteristics of the genotypes in which the departure time of inflorescences recorded earlier pertains to the genotype Nargeseh Saleh-Abad on March 17 and the latest time is related to the genotype of Agriculture Organization of Ilam 8 on April 29. In the table, the departure time of inflorescences for those in the south hillsides and the plain has been recorded earlier and for those in northern hillsides and mountains it was later. In the genotypes in the colder regions of the province with rainfall during the opening of inflorescences, the duration of flower completion has been recorded longer than opening of inflorescences until the first fruit production. The longest period of flower completion from the departure of inflorescence until the initial fruit production in the genotypes Agriculture Organization 8 (Ske8) was 33 days and the shortest period was recorded for the genotype Nargeseh Salehabad (NS) with 24 days and Kolah Faraj Salehabad with 23 days. In the genotypes Nargeseh Salehabad (NS) and Kolah Faraj Salehabad (KFS), temperatures get higher due to the proximity of Mehran Plain and the height below sea level that may affect the completion period of flowers. It was concluded that factors such as humidity, temperature, and altitude is very effective on phenological characteristics of olive. Above findings are consistent with Osborne et al (2000). The start of phenological activities in the genotypes studied is influenced by geographical location and regional temperature, and even the completion of flowering period is affected by weather conditions so that environmental stresses on the genotypes during the summer cause different changes in the departure time of inflorescences. The opening of buds of olive is affected by altitude and temperature of the region. Increasing the altitude is followed by decreased temperature, the growth conditions of the genotypes are also effective on the opening time of buds. In the regions with an altitude below the sea level, the weather gets warm sooner and the opening time of the genotypes in this region will be sooner, too. The presence of GM genotypes in the northern hillside and high altitudes have caused late opening of the buds. While higher altitudes in SK genotypes has affected the completion period of flowers. The presence of genotypes in the northern hillsides has caused the genotypes' growth to be faster and the fruit size to be larger that was the result of more appropriate temperature during growth and development and higher humidity. The length and number of inflorescences in genotypes with more favorable growth conditions were higher. Phenological behavior (time of flowering and opening time of flowers) of olive tree will be heavily influenced by environmental factors such as temperature, and the genotypes SK has the longest growth period for the completion of flowering period from the opening to the production of fruits. Flowering, formation, growth and development of the fruit of the olive tree are strongly influenced during low rainfall, high temperatures and low relative humidity, so the growth of branches and levels of carbohydrates in the tree are low and ultimately reduces production, performance and fruit weight loss. Olive tree phenology is influenced by environmental conditions so that it was announced in research in the Mediterranean area that the phenology of the olive and its development is associated with geographical conditions. In this study, the opening time of buds, development of inflorescence, maximum flowering, fruit production and hardening of the core were analyzed, and it was found that characteristics of the case and their development are in relation with geographical conditions. The altitude is very effective on the opening time of buds and their opening period, the phenological stages of olive are affected by the altitude (Fontana et al. (2006), Mara (2006), Sasarakyv (2005)). Since the concentration of temperature is higher in the southern hillsides and the regions get warm earlier, the phenological characteristics in these regions, such as departure time of inflorescences, fall of petals, and the fruit production time were affected, and thus different times were recorded for the genotypes studied. The above findings are consistent with Sasarakyv (2005). In the regions with higher rainfall and moderate temperature during pollination and inoculation, the rate and size of the flesh was more (Fontana et al., 2006). It is concluded that despite climate changes and higher ambient temperature, phenological characteristics of olive will be affected.

Table1: Variance analysis result of the number of inflorescence per branch and number of flower in inflorescence in different genotypes

Number of Flower In In Florescence	Number of Inflorescence Per Branch	df	Source of Variation
20/677**	141/818**	45	Treatment
3/66	3/241	138	Error
11/27	8/63		Cv

Table 2: Variance analysis result of the flower inoculated in open air, in bag, length of inflorescence and complete flower

Complete and Flower	Length of Inflorescence	Flower Inoculated in Bag	Flower Inoculated in Open Air	df	Source of Variation
797/652**	109/998**	97/998**	104/459**	44	treatment
21/456	1/930	1/096	2/030	135	error
10/84	5/16	18/77	18/03		cv

Table3: Mean comparison (Dunkan) of the number of flowers in inflorescence in branch and number flower in florescence

Number of inflorescence per Branch	Number Flower in inflorescence	Genotype	Row	Number of inflorescence per Branch	Number Flower in inflorescence	Genotype	Row
^{Defghi}13/75	28/25^{bcd}	BSCH3	23	^{defghi}15/5	21/75^{ghijkl}	NS1	1
^{defghi}16/5	16^{opqr}	BSCH4	24	^{defghi}16	16/75^{nopq}	NS2	2
^{bcdef}19	10^{s}	PCH1	25	^{defghi}16/25	17/75^{mnop}	NS3	3
^{ghi}14/5	12/5^{rs}	PCH2	26	^{bcde}19/25	13^{qrs}	NS4	4
^{defgh}15/75	21/75^{ghijkl}	SKE1	27	^{fghi}14/75	16/5^{nopqr}	NS5	5
^{bcdef}19	23/5^{efgh}	SKE2	28	^{defghi}15/5	16^{opqr}	NS6	6
^{defghi}17/25	24^{efgh}	SKE3	29	^{defghi}16/5	19^{jklmnop}	NS7	7
^{defghi}15/25	23/75^{efgh}	SKE4	30	^{defghi}17	15.75^{opqr}	NS8	8
^{efghi}15	23^{fghi}	SKE5	31	^{defghi}16	10/5^{s}	NS9	9
^{defghi}16/5	30/5^{bc}	SKE6	32	^{defghi}15/75	21/5^{ghijkl}	KFS1	10
^{ab}22/5	27/25^{cde}	SKE7	33	^{cdefgh}18/25	21/75^{ghijkl}	KFS2	11
^{abc}22/25	30/5^{bc}	SKE8	34	^{bcde}19/25	21/75^{ijklmno}	KFS3	12
^{defghi}15/5	25^{defg}	PG1	35	^{bcdef}19	19/25^{ijklmno}	KFS4	13
^{defgi}15/75	26/75^{cdef}	PG2	36	^{defghi}15/25	22/25^{ghijk}	KFS5	14
^{defghi}16/25	25/25^{defg}	PG3	37	^{bcdefgh}18/5	22/75^{ghij}	KFS6	15
^{efghi}15	29/5^{bc}	PG4	38	^{defghi}16/75	15^{pqr}	KFS7	16
^{efghi}18/75	29/5^{bc}	SBM1	39	^{hi}14	35/5^{a}	KFS8	17
^{defghi}16	32^{b}	SBM2	40	^{a}25	16/5^{nopqr}	KFS9	18
^{bcdefg}18/25	18/5^{klmnop}	GM1	41	^{bcd}19/5	15/75^{opqr}	KFS10	19
^{defghi}14/75	16/25^{opqr}	GM2	42	^{defghi}17/5	16/5^{nopqr}	KFS11	20
^{cdefgh}17/75	18^{lmnop}	GM3	43	^{defghi}17/5	15/5^{opqr}	BSCH1	21
^{fghi}15/25	20/25^{hijklmn}	GM4	44	^{Defghi}16/25	23/75^{efgh}	BSCH2	22

Table 4: Mean comparison (Dunkan) of the percentage of flower inoculated in open air, the percentage of flower inoculated in bag, length of inflorescence and complete flower

Length of inflorescence	Percentage of complete Flower	Flower inoculated in bag	Flower inoculated in open air	Genotype	Row	Length of inflorescence	Percentage of complete Flower	Flower inoculated in bag	Flower inoculated in open air	Genotype	Row
pq19/6	cdefg52/5	cd13/5	bc15	BSCH4	24	efh28/9	nop27	lmnopq3	ghijklm6/75	NS1	1
def30	r15	hijklmno4	lmno4/5	PCH2	25	fghi28	lmno32	lmnopq3	mno3/75	NS2	2
no22.5	bcd58	jklmnop3/5	hijklmn6	SKE1	26	efgh28/6	opq25	hijklmno4	lmno4/5	NS3	3
b34/9	abc61	fghijkl5/25	hijklmn6	SKE2	27	hijklm25/7	hijkl39	efghijk5/5	ghijklm6/25	NS4	4
ijklmn25	fghij45	efghij5/75	efgh18	SKE3	28	def30/3	mnop28	klmnop3/25	efghi8/75	NS5	5
nop22	bcde57	efghijk5/5	ghijklm6/5	SKE4	29	efgh28/6	lmno31/5	nopq2/5	klmno4/75	NS6	6
r14/6	ijklmn36	efghijk5/5	ghijklm6/75	SKE5	30	def29/8	nop27	nopq2/5	efghij8/25	NS7	7
hijklm25/75	efgh47	efghij5/75	ghijklm6/75	SKE6	31	bcd32/2	pqr18	lmnopq3	cd12/25	NS8	8
def30	ab67	efgh6/25	efg9/25	SKE7	32	jklmn24/7	qr16	q0/75	lmno4/25	NS9	9
ijklmn25	abc59	c14/25	b16/25	SKE8	33	Jklmn24/7	efgh47	efgh6/25	def10/75	KFS1	10
nop22	ghijk42	ijklmno3/75	fghijkl7/75	PG1	34	lmno24/2	cdef54	ghijklmno4/25	ghijklm6/75	KFS2	11
mno23	jklmno35	hijklmno4	jklmno5/25	PG2	35	fghi28	fghij45	pq1/25	ghijklm7	KFS3	12
lmno24	bcde57	efghi6	ghijklm7	PG3	36	ghijklm26	mnop28	opq2/25	o2/75	KFS4	13
ghijklm26	a69	klmnop3/25	klmno4/75	PG4	37	opq21/5	hijklm38	ijklmno3/75	ijklmno5/75	KFS5	14
a42/2	cdef46	b22/75	a25/75	SBM1	38	mno23	ghijk43	ijklmno3/75	lmno4/25	KFS6	15
bc33/2	ab52	a25/5	a26/5	SBM2	39	q18/8	mnop28	opq2/25	mno3/75	KFS7	16
ghijklm26	bc54	ef7	cd12/25	GM1	40	fghijk27/5	klmno34	pq1/25	lmno4/5	KFS8	17
fghij27/75	hijklm66	e7/75	de11	GM2	41	cde31/3	defgh48	mnopq2/75	mno3/75	KFS9	18
b35	mnop58/75	efg6/5	efgh9	GM3	42	ghijkl26/5	hijkl39	opq2	mno3/75	KFS10	19
a42	lmno38	fghijklm5	ghijklm7	GM4	43	jklmn24/8	abc62	fghijklmn4/75	klmno7/5	KFS11	20
ghijkl26/6	fghi28	opq2/25	no3	DE1	44	def30/1	hijklm38	fghijklmn4/75	ghijkl5	BSCH1	21
klmn24/5	cdefg31	nopq2/5	lmno4/25	DE2	45	klmn24/5	cdefg52	d11/75	bcd13/5	BSCH2	22
						mno23	defgh48	ef7	efghij8/25	BSCH3	23

Table 5: Phenological characteristic

Fruit Ripe Time	Initial fruit production	Fall of Petals	Duration of the flower Completion	Completion time of Flower	Opening time of Flower	Departure time of Inflorescence	Genotype	Row
15m	31f	27f	24	25f	21f[2]	27e[1]	NS1-9	1
18m[4]	3o[3]	29f	25	27f	24f	29e	KFS1-3	2
18m	3o	29f	23	27f	24f	2f	KFS3-11	3
16m	7kh[5]	30o	30	26o	22o	24f	BSCH1-4	4
19m	7kh	31o	29	27o	23o	26f	PCH2-4	5
25m	7kh	4kh	33	31o	28o	27f	SKE1-7	6
25m	8kh	5kh	32	2kh	29o	29f	SKE8	7
28m	4kh	2kh	29	28o	24o	27f	PG1-4	8
9m	28o	26o	31	21o	18o	19f	SBM1-2	9
26m	2kh	30o	27	26o	23o	28f	GM1-4	10
12	1kh	29o	27	24o	20o	25f	DZ1-2	11

1- Murch, 2- April, 3- May, 4- October, 5- June

Table6: Determination of geographical characteristics and location of genotypes

Growth Location	Latitude	Longitude	Altitude	location	Genotype	Row
Southern	33˚ 34′ 10″	46 ˚16 ′51″	1205	Saleh abad	NS1	1
Southern	33˚ 33′45″	46 ˚16 ′8″	1249	Saleh abad	KFS1	2
Southern	33˚ 48′ 35″	46 ˚9 ′9″	1210	Saro chevar	BSCH1	3
Northern	33˚ 48′ 15″	46˚ 8′18/5″	1212	Parde chovar	PCH1	4
Plain	33˚ 12″35′	46˚ 24′ 14″	1420	Department of Agriculture	SKE1	5
Southern	33˚ 7/7″28′	46˚ 45′2/6″	1320	Pakel garab	PG1	6
Eastern	33˚ 1/6″20′	46˚ 29′27/3″	1130	Malekshahi	SBM1	7
Northern	33˚ 15/6″24′	46˚ 49′49″	1048	Ganje mishkhas	GM1	8
Northern	33˚ 31/7″52′	46˚ 8′6/1″	1040	Darg zane	DZ1	9

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