EFFECT OF DIFFERENT AMOUNTS OF WINTER CHILLING ON FRUITFULNESS OF SEVERAL OLIVE VARIETIES

H. T. HARTMANN AND I. PORLINGIS

Introduction

It has been shown previously (**3**) that the olive (*Olea europaea* L.) requires winter chilling to induce flower-bud differentiation, which in California occurs about mid-March, followed by blooming in May (**1**). Vegetative growth, however, proceeds satisfactorily without any winter chilling. This situation is quite different from that found in most deciduous fruit species where flower-bud differentiation takes place the previous summer and the winter-chilling period serves only to overcome the rest period of the buds. Unlike the olive, too, vegetative buds in deciduous species require a chilling period in order to resume satisfactory growth in the spring.

The present investigation was undertaken to determine whether differences in the chilling requirement for flower formation exist among different olive varieties and, if there are varieties with a low chilling requirement, to examine the possibility of using them in areas of relatively warm winters.

Experimentation and results

Experiments 1954–55.—Olive trees 3 years old and of seven different varieties (table 1) were grown in 3-gallon cans. All trees were propagated by grafting on the same clonal rootstock, variety Oblonga, and were fairly uniform in size. In the winter of 1954–55 the trees of each variety were divided into four groups of three trees each. Group A was placed in a greenhouse October 1 and received no chilling throughout the winter. The temperature in the greenhouse was thermostatically controlled with a minimum of 60° F. Trees in group B remained out of doors until December 15, when they were brought into the greenhouse after receiving 578 hours below 45° F. Group C was brought in January 15, after receiving 1212 hours below 45° F. Group D remained out of doors the entire winter, receiving 2143 hours below 45° F.

Shortly after each group was brought inside, vegetative growth activity resumed, and after 3–4 weeks under greenhouse temperatures inflorescences began to appear. At full bloom the total number of inflorescences per tree, the average number of flowers per inflorescence, and the percentage of perfect flowers were determined. The olive normally produces two flower types—perfect and staminate. After fruit-setting was complete, the number of fruits per tree was counted.

Table 1 gives the results of the effects on fruitfulness of the differential winter chilling given the seven varieties used.

Experiments 1956–57.—The same trees used in the 1954–55 tests were again used. In addition, trees of the Criolla variety were included. The tests were conducted in essentially the same manner as described for the 1954–55 studies, the trees of each of the eight varieties being divided into four groups of three trees each. Four levels of chilling were obtained—group A was brought into the greenhouse on October 3, receiving 4 hours below 45° F.; group B was brought in on December 18, after 613 hours below 45° F.; group C was brought in on February 1, after 1326 hours below 45° F.; while group D remained out of doors the entire winter, receiving 1657 hours below 45° F.

The results obtained in the 1956–57 tests are given in table 2.

Discussion

In confirmation of earlier studies (**3**), in the absence of winter chilling no inflorescences were produced on any trees of any of the varieties used. With all varieties except Rubra and Azapa, maximum infloresence and maximum fruit production per tree were obtained in both years with the maximum amount of chilling given. For trees given the intermediate amounts of chilling, the results were somewhat erratic; in several cases trees in the B group produced more inflorescences and fruits than those in the C group, even though the latter had a greater amount of chilling. In general, however, trees receiving an intermediate amount of chilling produced intermediate numbers of inflorescences and fruits.

The numbers of fruits produced per tree were not always consistent with the numbers of inflorescences present. In the olive, fruit-setting tends to be quite erratic; thus numbers of inflorescences or flowers may not be highly correlated with numbers of fruits.

In addition, the pollination and fruit-setting periods in the different groups occurred at different times when temperature conditions would be somewhat different. Principal emphasis in the results should, therefore, be laid on temperature effects on inflorescence production rather than on fruit production.

Another possible method of providing differential chilling treatments which would permit blooming and fruit-setting at the same time and under the same conditions for all plants would be to start with all groups in the greenhouse at the beginning of winter. Then at different times during the winter the different groups of plants could be placed out of doors with growth activity subsequently starting in all plants at the same time in the spring. This method was tried but discarded in earlier tests. Those plants kept in the greenhouse produced a succulent vegetative growth in early winter which was subsequently injured severely by low temperatures when the plants were moved out of doors to receive their chilling treatment.

la, Barouni, and Manzanillo, which produced some inflorescences with only a slight amount of winter chilling but, generally, far below the numbers possible when greater amounts of chilling were given.

The varieties Rubra and Azapa may be placed in a third group. In the 1954–55 experiments these behaved like the varieties in the second group, but in the 1956–57 tests they flowered as well with low chilling as with complete chilling. Rubra produced 227 inflorescences per tree after 613 hours under 45° F. and 187 inflorescences after 1657 hours under 45° F. Azapa produced 41 and 54 inflorescences per tree, respectively, under the same conditions. Although the results are not consistent for the two years, the 1956–57 experiment indicates that it is possible for only a slight amount of chilling to induce considerable inflorescence production in these two varieties.

TABLE 1

EFFECT OF DIFFERENT AMOUNTS OF WINTER CHILLING ON THE FRUITFULNESS OF SEVERAL OLIVE VARIETIES. AVERAGE OF THREE TREES PER TREATMENT. 1954–55

	Average no. inflorescences per tree				Average no. flowers per inflorescence				Average % of perfect flowers				Average no. of fruits per tree			
Variety	A	B	C	D[a]	A	B	C	D	A	B	C	D	A	B	C	D
Rubra	0	43	11	314	–	19	18	16	–	61	87	53	–	0	0	108
Azapa	0	30	8	240	–	–	10	10	–	–	29	50	–	–	0	14
Mission	0	29	31	336	–	5	10	14	–	15	20	20	–	1	2	37
Manzanillo	0	0	6	249	–	–	4	9	–	–	2	38	–	0	0	14
Barouni	0	27	22	189	–	5	8	8	–	43	61	74	–	11	2	67
Ascolano	0	0	0	152	–	–	–	11	–	–	–	25	–	–	–	3
Sevillano	0	9	2	198	–	7	10	8	–	41	1	23	–	4	0	22

[a] Hours below 45° F.: group A, 0; group B, 578; group C, 1212; group D, 2143.

TABLE 2

EFFECT OF DIFFERENT AMOUNTS OF WINTER CHILLING ON THE FRUITFULNESS OF SEVERAL OLIVE VARIETIES. AVERAGE OF THREE TREES PER TREATMENT. 1956–57

	Average no. inflorescences per tree				Average no. flowers per inflorescence				Average % of perfect flowers				Average no. of fruits per tree			
Variety	A	B	C	D[a]	A	B	C	D	A	B	C	D	A	B	C	D
Rubra	0	227	40	187	–	16	10	16	–	94	67	62	–	18	1	68
Azapa	0	41	59	54	–	14	11	14	–	80	86	85	–	2	3	8
Mission	0	8	111	328	–	10	8	14	–	76	18	32	–	1	5	74
Manzanillo	0	14	40	132	–	8	8	11	–	71	39	51	–	0	14	18
Barouni	0	2	21	88	–	–	–	11	–	88	78	48	–	0	21	62
Criolla	0	0	41	132	–	–	15	–	–	–	72	–	–	–	7	7
Ascolano	0	0	1	289	–	–	7	14	–	–	28	10	–	–	0	6
Sevillano	0	0	1	57	–	–	10	–	–	–	63	–	–	–	0	3

[a] Hours below 45° F.: group A, 4; group B, 613; group C, 1326; group D, 1657.

No consistent influence on numbers of flowers per inflorescence or on the percentage of perfect flowers is apparent. The primary effect of chilling is on the number of inflorescences produced.

A varietal response in inflorescence production to the differential chilling is evident. Three groupings may be made: In one group two varieties, Ascolano and Sevillano, seemed to require the maximum amount of chilling given in these tests before appreciable numbers of inflorescences were produced. Such varieties should thus be planted only in areas characterized by a relatively large accumulation of hours below 45° F. during the winter months. The olive tree itself will not withstand minimum temperatures much below 15° F., however.

In a second group are the varieties Mission, Criol-

In a survey (2) of the bearing habits of forty-two olive varieties in California, Rubra was outstanding for its consistent fruitfulness, being the only variety to be rated as bearing a heavy crop each year for the 6 years such records were taken. It is thus possible that in years of unusually warm winters, which are occasionally encountered in California, the low amount of chilling was sufficient for inflorescence production in this variety but deficient for other varieties, such as the Ascolano and Sevillano, which seem to require large amounts of winter chilling. The Rubra variety, with its apparent low chilling requirement for fruitfulness and heavy bearing tendencies, would thus presumably be well adapted to such areas as southern California which have relatively warm winters. Unfortunately, this variety produces a rather undesirable fruit, being small (about 2 gm. in comparison with Mission, a commercial California variety, at 5 gm.) and with a low flesh-pit ratio (1.5:1 in comparison with Mission with 2.0:1). The oil content of Rubra fruits is also rather low—15% of the fresh weight in comparison with about 20% for Mission (2). Rubra may be of value, however, in breeding programs as a source for the characteristic of good fruitfulness even with low amounts of winter chilling.

The Azapa variety, the second variety which may possibly be fruitful in areas of low winter chilling, would be more suitable for use as a table olive, producing fruits of moderate size, averaging 4.5 gm. per fruit.

Summary

1. Inflorescence and subsequent fruit production in eight varieties of olives was, in general, directly proportional to the amount of winter chilling received. Trees of each variety maintained in a warm greenhouse throughout the winter failed to produce a single inflorescence.

2. The number of flowers per inflorescence or the percentage of perfect flowers produced was not affected by the amount of winter chilling.

3. The varieties Ascolano and Sevillano required the maximum amount of winter chilling encountered at Davis, California, during each of two winters before appreciable amounts of inflorescences were produced.

4. The varieties Mission, Criolla, Barouni, and Manzanillo produced some inflorescences with intermediate amounts of chilling, although considerably more developed with the full amount of chilling.

5. In the 1956–57 tests the Rubra and Azapa varieties were able to produce substantial numbers of inflorescences under the minimum amount of chilling given, indicating that they might be adaptable to regions of relatively high winter temperatures.

DEPARTMENT OF POMOLOGY
UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA
AND
COLLEGE OF AGRICULTURE
UNIVERSITY OF THESSALONIKE
THESSALONIKE, GREECE

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FLORAL MORPHOLOGY AND EMBRYOLOGY OF SAMADERA INDICA

N. C. NAIR AND T. C. JOSEPH

Introduction

The Simaroubaceae is a predominantly tropical family of woody members (**2**, **4**). The genus *Samadera* (tribe Eusimaroubae) comprises three species, of which two, *S. indica* Gaertn. and *S. lucida* Wall., occur in India (**3**).

SCHNARF (**13**) has reviewed the earliest works on the embryology of the Simaroubaceae. WIGER (**14**) investigated fifteen species in which *S. indica* was included, but his work was adversely criticized by MAURITZON (**6**). Recently RAU (**10**) studied the embryology of *Suriana maritima* and has confirmed some of WIGER's observations. Except for the account by SAUNDERS (**12**) of *Ailanthus glandulosa* and *Quassia amara*, no information is available regarding the vascular anatomy of the flower in the family. The present work is mainly devoted to the floral anatomy and embryology of *S. indica*. The vascular anatomy of *S. lucida* has also been studied for comparison.

Material and methods

S. indica is a common glabrous tree of Canara, Kerala State, and Ceylon. The material for the present study was secured and fixed in formalin–acetic-alcohol from plants growing under natural conditions in Perunnai, Changanacherry, Kerala State, in June and July of 1954 and of 1955. Only two herbarium buds of *S. lucida* were available. They were treated with 2% sodium hydroxide for 12 hours and then washed and fixed in formalin–acetic-alcohol. Customary methods of dehydration and imbedding were followed, using xylene as the clearing agent. Serial microtome sections cut at 8–14 μ were stained in safranin and fast green.