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Genetic Diversity and Clonal Variation among Olive Cultivars Offer Hope for Selecting Cultivars for Texas

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Abstract

Some researchers in the past have discouraged the cultivation of olives as a commercial crop in Texas. Their argument was primarily based on the temperature data of olive growing areas in the world versus the climatic conditions in Texas. Actual growth and performance of olive trees was not tested at any location in Texas. However, approximately 5-6 years ago, interested farmers started a few olive groves on a trial basis at different locations in the Texas Valley. Normally, olive trees mature and then start flowering and fruiting within 4-6 years; early maturing cultivars can produce fruits within a year. A survey on the performance of these trees was, therefore, conducted during the 2002 and 2003 seasons to ascertain whether adaptability to local climatic conditions exists among clones of various olive cultivars planted at different locations. The survey identified clonal variation among two trees with striking adaptability to local climatic conditions thus producing flowers and fruits under conditions in which other olive cultivars did not flower. In addition, several trees were identified that produced remarkably well at different locations under climatic conditions that were marginally conducive to flowering. This information about the adaptability of some trees, exhibiting clonal variation, to the Valley climate offers hope that promising cultivars of olives could be developed for Texas by tapping into natural genetic diversity, clonal variation, and the adaptability of olive plant accessions to local climatic conditions. Additionally, there is a need to further evaluate the performance of selected trees and to import more cultivars from areas with climatic conditions similar to Texas for additional testing at different sites in Texas.

Introduction

Historically, olives have not been grown commercially in Texas. Denney and McEachern (4) conducted a detailed survey of the temperature regimes in various olive growing locations in the world and two control areas (i.e. where olives do not flower; Weslaco, Texas was selected as one of those controls), and concluded that, based on temperature requirements for fruiting, there are very few sites in Texas where olives could be grown profitably. According to their assessment, temperatures in the southern parts of Texas Valley (Rio Grand Valley) do not get cold enough in the winter to induce consistent annual flowering. In other areas of Texas, occasional frost damage would periodically kill the trees. These conclusions were supported by the findings of Hartmann and associates (1,6,8) who conducted several experiments on flowering in olives and suggested that during the flower induction period in California, optimum temperatures for olive production range between 2-4 °C at night and 15.5-19 °C during the day. These temperatures either do not occur or occur inconsistently in different regions of Texas Valley.

However, in the experiments mentioned above, only a few common olive cultivars were used, whereas, more than two thousand cultivars and clones of olives are grown worldwide (9). It has also been recognized that some of these cultivars or clones require less chilling for flower production (7), and others show cold tolerance (12). Even within the same cultivar, different plant accessions have shown considerable adaptability to micro climatic conditions. Such clonal

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variations have allowed for the selection of promising lines or cultivars (11). Thus, the vast genetic diversity and the ability of olives to adapt to different climatic conditions offer possibilities and opportunities for appropriate cultivars or clone selection for different Texas Valley regions.

During the last 5-6 years, a few farmers and ranchers have planted several cultivars of olives in various Texas Valley regions, mostly in the upper valley but including one location in the lower Rio Grand Valley (Fig 1). Since most olive cultivars reach maturity within 4-6 years (9), we conducted a survey of various locations during 2002 and 2003 to see if any cultivars or clones planted at different sites have shown compatibility to local climatic conditions. We were particularly interested as the mild winter of 2001-02 was thought unsuitable for flowering in olives. In general, the results of these surveys provided encouraging information for developing future cultivars for Texas Valley. These are early findings but they may prove valuable for later selection.

Materials and Methods

Fruiting data on olive cultivars and clones were collected during the 2002 and 2003 seasons from four sites: 1) Sandy Oak Ranch (10 miles south of San Antonio TX; N 28.52 latitude; W 98.33 longitude and 157 m elevation) 2) Andersons farm at Dilley, TX (N 28.67 latitude; W 99.17 longitude; and 173 m elevation 3) Moro Creek Ranch (7 miles east of Carrizo Springs TX; N 28.52 latitude; W 99.86 longitude; 184 m elevation), and 4) James Anderson Garden (5 miles east of Weslaco TX; N 26.16 latitude; W 97.96 longitude; 24 m elevation) (Fig.1). The majority of the trees at these sites were planted in 1997 or 1998 except at the last site, Anderson Garden, which was planted in 2000. Therefore, trees were at least 4 years old at the time of scoring, except at the Anderson's site near Weslaco where only

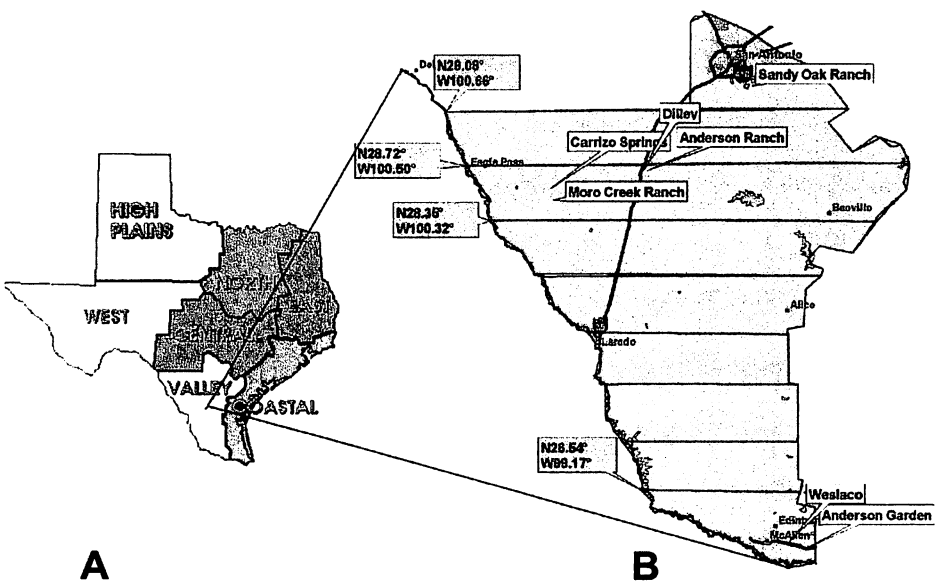

Figure 1. Figure 1A shows the map of Texas and the boundaries of Texas Valley based on Texas State Travel Guide published by Texas Department of Transportation. Figure 1B shows specific sites within Texas Valley where olive groves were developed in the last 5-6 years that were surveyed in 2002 and 2003.

early maturing trees (e.g., 'Arbequina') should have fruited. A visual scoring system ranging from 0 to 10 was used to score the extent of fruiting in individual trees. Plants without fruits scored 0, heavily fruited plants scored 10, and plants showing intermediate fruiting were assigned a number ranging from 1-9 depending on the extent of fruiting. Examples of the 'Arbequina' trees scored 1, 5, and 9 are given in figures 2A, 2B, and 2C respectively to illustrate the scoring guidelines that were used. The trees were scored in August when plants had fully developed fruits. Two individuals scored the plants simultaneously and the combined score was recorded.

In order to confirm that plantings were indeed the cultivars they were claimed by the owner of the olive grove, a promising olive clone selected at Moro Creek Ranch was first sent to Dr. Barranco of University of Cordoba, Spain, for morphological identification, and then to Dr. Jenny Guerin of Adelaide University, Australia, for identification by DNA fingerprinting (5). A second clone selected from Anderson Garden (5 miles from Weslaco TX) was sent to Dr. Claros of University of Malaga, Spain, for identification through DNA fingerprinting (3).

Records of temperature data were obtained from the internet Accuweather® site (www. Accuweather.com).

Results and Discussion

The 2002 season was not conducive to olive flowering at the Carrizo Springs, Dilley, and Weslaco sites in Texas. Perhaps the temperatures during that season did not provide appropriate conditions that were required for flower induction (Fig. 3A and B). With the exception of one tree near Carrizo Springs, TX in Moro Creek Ranch (Row number 12, plant number 7; named L712) all other olive trees of different cultivars throughout these sites had few or no fruit (Tables 1-3). The tree L712 scored five according to our scoring scheme (Fig 2). Trees at the site near San Antonio, TX (Sandy Oak Ranch) did not produce any fruit but this was due to frost damage that occurred at that site in late February of 2002 rather than lack of enough chilling for flowering (Fig. 3C)

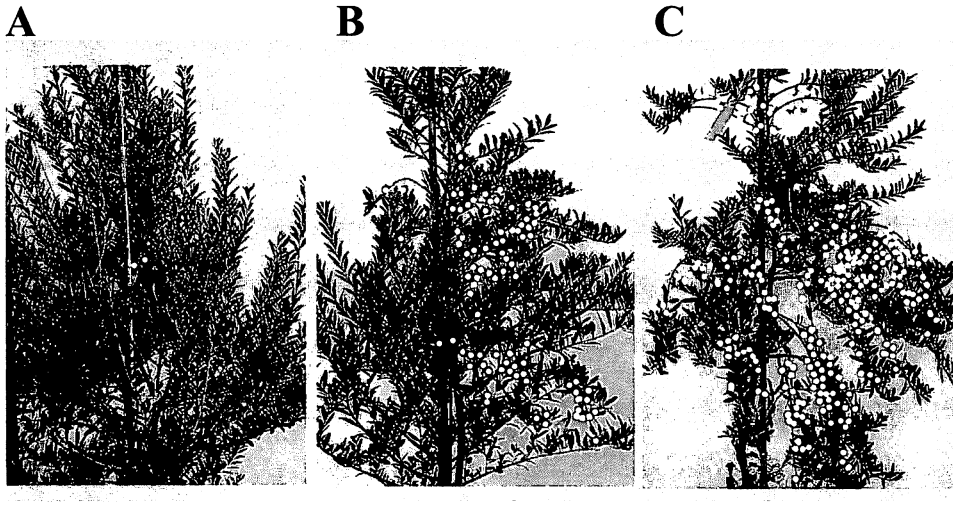

Figure 2. Typical plants showing the extent of fruiting as marked by scores of 1 (A), 5(B), and 9 (C). Olives on the trees are identified by white dots

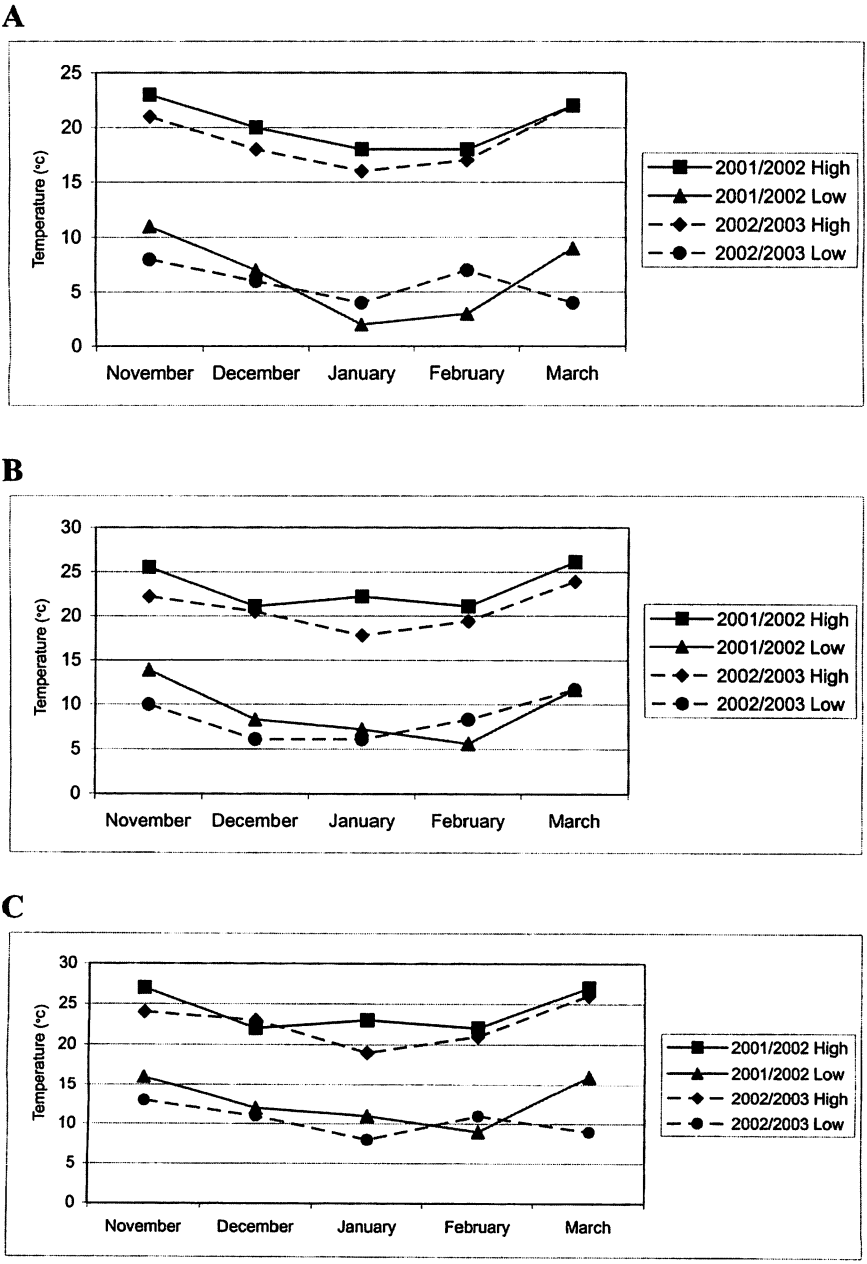

Figure 3. Monthly mean temperatures during the winters of 2001-02 and 2002-03 for Sandy Oak Ranch near San Antonio (A), Anderson's Ranch in Dilley and Moro Creek Ranch near Carrizo Springs (B), and Anderson Garden near Weslaco (C). Anderson's Ranch and Moro Creek Ranch were so close that the same weather station was used to describe weather data for both sites.

Morphological characteristics of seeds of tree L712 were checked by Dr. Diego Barranco of University of Cordoba, Spain (2); DNA fingerprinting was done by Dr. Guerin at Adelaide University in Australia (5). Neither laboratory was able to identify the tree based on their data bases. The tree L712, however, is of great interest for potential commercial cultivation in Texas for the following reasons. First, it was able to produce fruits in Texas under environmental conditions not thought suitable for olive fruiting. Second, it flowered and fruited the following 2003 season. It flowered in mid-February, at least two weeks earlier than any other tree in all the sites. The fruits on L712 also matured earlier, in mid-August, than any of the other cultivars. Early flowering in olives could be desirable characteristic for olive cultivation in southern Texas Valley because temperatures in Texas Valley can occasionally rise to as high as 38°C in mid-March or early April. High temperatures soon after flowering could adversely affect fruit set and development. Thus, flowering in February would be advantageous for growing this plant in areas where frosts in late February and/or early March seldom occur, because flowers could set fruit before the occurrence of a heat wave. In addition, the L712 tree received a score of 5 for extent of fruiting in both 2002 and 2003. Cuttings from this tree have been rooted and the scions from this plant have been grafted onto different rootstocks to study in detail the characteristics of the clones of this tree at various locations in Texas.

The 2003 season was suitable for flowering and fruiting in several cultivars at the first three sites (Fig 3A-B) surveyed but not for the site near Weslaco (Fig. 3-C), but still one tree at this site (Anderson Garden near Weslaco) produced flowers and fruits. The fruiting tree was 'Arbequina' (sub-culture I -18), planted in 2000. This was the only tree that flowered and fruited, though poorly (scoring 4), at that site. The flowering of this tree is especially significant in light of the fact that Denney and McEachern (4) considered this area as noninductive for flowering in olives, i.e., where olives only grow vegetatively. Temperature conditions during 2003 were not conducive to flowering (Fig. 3C) according to the criteria developed by Denny and McEachern (4). This is another tree of cultivar 'Arbequina' I-18 that may offer hope for future olive cultivation in Southern Texas Valley.

In addition to the two trees mentioned above, our surveys identified a few more trees of practical importance for an olive industry in Texas (Tables 1-3). For example, at Sandy Oak Ranch near San Antonio, fruiting in one 'Arbequina' tree scored as

Table 1. Fruiting response in olives trees of different cultivars grown in Sandy Oak Ranch near San Antonio.

Cultivar	Year* scored	Total plants	Number of plants in each scoring category						Percent fruited	Percent scored ≥5
			(0)	(1-2)	(3-4)	(5-6)	(7-8)	(9-10)		
Arbequina	2003	3491	3038	306	111	26	9	1	13	1
Empeltre	2003	14	14	0	0	0	0	0	0	0
Frantoio	2003	853	849	3	0	0	1	0	1	0
Koroneiki	2003	2	2	0	0	0	0	0	0	0
Leccino	2003	40	40	0	0	0	0	0	0	0
Lucca	2003	15	15	0	0	0	0	0	0	0
Manzanillo	2003	15	15	0	0	0	0	0	0	0
Maurino	2003	3	3	0	0	0	0	0	0	0
Mission	2003	23	22	1	0	0	0	0	4	0
Pendolino	2003	8	7	0	0	1	0	0	13	13
Picual	2003	47	47	0	0	0	0	0	0	0
Sevillano	2003	10	10	0	0	0	0	0	0	0

*In 2002 none of the trees bore fruits.

high as 9, and another scored 8, while nearly 3000 trees of the same cultivar, of the same age or older, and at the same site had no fruit. At the Moro Creek Ranch, there were five trees of 'Arbequina', out of approximately 300 trees, that also scored 9-10 (Table 2). In addition, there were 3 'Manzanillo' trees (out of a total of 16 trees) and 2 'Mission' trees (out of a total of 219) trees that heavily fruited in the 2003 season

Table 2. Flowering response in olives trees of different cultivars grown in Anderson's Ranch in Dilley.

Cultivar	Year scored	Total* plants	Number of plants in each scoring category (0)	(1-2)	(3-4)	(5-6)	(7-8)	(9-10)	Percent flowered	Percent scored ≥5
Frantoia	2003	20	13	6	1	0	0	0	35	0
	2002	20	20	0	0	0	0	0	0	0
	2001	20	13	6	1	0	0	0	35	0
Leccino	2003	27	23	4	0	0	0	0	15	0
	2002	27	27	0	0	0	0	0	0	0
	2001	27	9	16	2	0	0	0	67	0
Maurino	2003	15	0	1	3	2	2	7	100	73
	2002	15	15	0	0	0	0	0	0	0
	2001	15	0	1	1	2	4	7	100	87
Pendolino	2003	17	2	1	5	2	6	1	88	53
	2002	17	17	0	0	0	0	0	0	0
	2001	17	1	0	3	0	9	4	94	77

* Only healthy plants were included in this survey; several trees at this site were stunted, defoliated, and/or dried.

Table 3. Fruiting response in olives trees of different cultivars grown in Moro Creek Ranch near Carrizo Springs.

Cultivar	Year scored	Total plants	Number of plants in each scoring category (0)	(1-2)	(3-4)	(5-6)	(7-8)	(9-10)	Percent fruited	Percent scored ≥5
Arbequina	2003	51	22	16	7	4	0	2	57	12
	2002	51	51	0	0	0	0	0	0	0
Arbequina II*	2003	258	47	90	73	21	23	3	82	18
	2002	0	0	0	0	0	0	0	0	0
Frantoio	2003	26	21	4	0	1	0	0	19	4
	2002	26	21	0	0	0	0	0	0	0
Leccino	2003	40	29	8	2	1	0	0	28	3
	2002	40	40	0	0	0	0	0	0	0
L712	2003	1	0	0	0	1	0	0	100	100
	2002	1	0	0	0	1	0	0	100	100
Manzanillo	2003	16	6	2	1	3	1	3	63	44
	2002	16	15	1	0	0	0	0	6	0
Maurino	2003	6	3	2	1	0	0	0	50	0
	2002	6	6	0	0	0	0	0	0	0
Mission	2003	219	42	53	70	41	11	2	81	25
	2002	219	214	5	0	0	0	0	2	0
Picual	2003	19	1	3	9	4	2	0	95	32
	2002	19	19	0	0	0	0	0	0	0
Sevillano	2003	3	0	2	1	0	0	0	100	0
	2002	3	3	0	0	0	0	0	0	0

* These trees, of early maturing cultivar, were planted in 2002. Other trees were planted in 1997-1998.

at Moro Creek Ranch (Table 2). Records on extent of flowering (scored 1-10; 10 being the best) during the last three years were meticulously maintained by owners of Anderson's Ranch in Dilley. Based on their information, it also appeared that certain trees of the 'Maurino', and one tree of 'Pendolina' performed quite well there.

The results described in this report indicate that there may be a few clones of olive trees capable of producing fruit in Texas Valley. Although Texas may not be generally suitable for growing olives (10), there appears hope that adaptability in certain olive cultivars/clones could offer opportunities to select, and, possibly, develop suitable cultivars for Texas. While evaluation of already selected plants should continue, it is also important to bring more cultivars from similar climates (e.g., Mexico, Egypt, and Tunisia) for testing at various locations in Texas.

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Water Stress and Crop Load Affect Fruit Growth on Young Peach Trees

During three stages of fruit growth,the combined effects of water stress and crop load on fruit water content and dry-matter accumulation were studied. Irrigation was withheld during Stage I, II, or III and compared to a fully irrigated control. Three crop load treatments (low, medium, and high) were imposed on each irrigation treatment. Fruit were sampled at the end of Stages I, II, and III for determination of total tree fruit fresh and dry matter. At high fruit loads at all stages of fruit development, water stress markedly reduced fruit water accumulation. This effect was greater in Stages II and III than in Stage I. In contrast, fruit dry matter accumulation was relatively unaffected by water stress at any crop load in any developmental stage. From Girona, J., J. Marsal, M. Mata, A. Arbones, and T.M. DeJong. J. Hort. Sci. Biotech. 79:308-315.