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SCANNING ELECTRON MICROSCOPY OF FLORAL INITIATION AND DEVELOPMENTAL STAGES IN 'GLOHAVEN' PEACH (*PRUNUS PERSICA* L.) UNDER WATER DEFICIT

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Abstract

The influence of different irrigation conditions on flower bud development of the peach cv. 'Glohaven' was studied using scanning electron microscopy. The bud samples were taken every ten days from August 2 to October 2004-2005. Flower bud development under three irrigation treatments was compared. With optimum irrigation, T_1, trees were irrigated at approximately 100% ET. T_2 and T_3 trees received 50 and 20% of the water applied to the T_1, respectively. The rate of flowering at the stage of differentiation of sepal, petal, stamen and pistil primordia was considerably slower at T_3 compared with T_2 and T_1 water. When water was not provided in the next year, flower bud initiation and differentiation was delayed. Results indicated that decreasing irrigation slowed the progression of flower initiation and differentiation.

Introduction

For peach cultivars in western Turkey, approximately 70% of seasonal evapotranspiration occurs after harvest, and flower bud initiation and development occur during this period (Ryugo 1986, Westwood 1993). Studies by Brown (1952) and Uriu (1964) indicated that post-harvest water stress in apricots had detrimental effects on flower bud initiation and subsequent fruiting. In pears water stress inhibited the final steps of bud development (Proebsting and Middleton 1980, Marsal *et al.* 2000). Flower bud initiation and differentiation are important for developing management strategies to enhance flowering and ultimately to regulate fruit crop loads. Faust (1989) suggested that floral induction starts through a biochemical signal that causes cells within a bud to begin programmatic transitions from a vegetative to a floral stage. After that, flower primordia, sepals, petals and stamens, differentiate sequentially, and pistil primordia are initiated (Ryugo 1986), and in this period, water deprivation might be expected to cause variation in flower differentiation.

The objective of this study was to investigate the effect of water stress on progression of flower differentiation using scanning electron microscope (SEM).

Materials and Methods

This study was conducted in an orchard located near University of Ege, in Turkey. Ten-year-old 'Glohaven' peach (*Prunus persica* L.) grafted on 'Nemaguard' was used. Tree spacing was 5 m × 5 m. Soil type was a fine sandy loam. Five trees were used per treatment.

Irrigation treatments started in May and trees were irrigated every ten days during two seasons 2004 and 2005. The control trees (T_1) were irrigated with sufficient water to supply approximately 100% evapotranspiration (ET). The light water stress treatment (T_2) received 50% of the water applied to the control. The severe water stress treatment (T_3) received 20% of the water applied to the control.

Buds of uniform size and vigor were collected at every ten days from five trees with effect from August 2 to October 1 in both the years. The samples were fixed and stored in a solution of FAA. Ten buds from each sample were dissected using an Olympus SZ 60 stereomicroscope before processing for SEM. Buds were rinsed twice (10 min each) in 50% ethanol to remove the FAA from the plant tissue and were kept in 50% ethanol during dissection to prevent desiccation. Later, the sample were dehydrated in an ethanol series (50, 70 and 95% for 10 min, each) and twice in 100% alcohol for 10 min each (Guimond *et al.* 1998). The samples were dried with a critical point dryer and stored in a desiccator over anhydrous $CaSO_4$. The sample mounted on stainless steel stubs with carbon tape before being gold coated with a sputter coater (Polaron SC 502). The samples were examined with a scanning electron microscope (Jeol ISM 5200). The photographs of morphological differentiation of the samples examined were taken with the camera attached to SEM. The progression of flower differentiation was observed by SEM and the developmental stages of the flower buds was classified as described for almond by Unal (1987).

Results and Discussion

The use of SEM revealed the developmental stages of the flower buds in 'Glohaven' peach (Fig. 1). The first sign of floral initiation occurs when the meristematic apex of the bud becomes dome-like in shape (Fig. 1A), in which floral organs were destined to differentiate laterally. After bud differentiation, floral primordia developed in the order of flower primordia, sepal, petal, stamen and pistil, and these organs obtained their normal forms by the end of September. Results of flower bud development within different irrigation treatments are shown in Tables 1 and 2. In the first samples with irrigation treatments in 2004, there were considerable differences on the progression of flower bud formation (Table 1).

Under optimum irrigation (T_1) the differentiation of sepal, petal and stamen primordia progressed rapidly, and more than 15% of the buds had formed pistil primordia by September 1. Under low water stress (T_2), the differentiation process was slightly slower, but 4% of the buds had differentiated pistils by September. In contrast, under severe water stress (T_3), sepal and petal primordia began to differentiate as late as mid to late August, and only 4% of the buds had differentiated pistils on September 11.

In 2005, the first samples were obtained at the beginning of August when 20% of the flower buds in treatment T_1 were at the stage of petal primordia. In treatment T_2, 6% of the buds were at the stage of petal primordia. In treatment T_3, most of the flower buds were found at the stage of flower primordia (Table 2).

In flower buds collected at the beginning of September, the most advanced developmental stage was observed in treatment T_1, with 31% of the buds at the stage of pistil primordia. In the T_2 treatment, 14% of the flower buds were at the stage of stamen primordia, with 10% at the stage of pistil primordia. In treatment T_3, petal primordia were initiated in about 24% of the buds. However, stamen and pistil initiation are not observed and thus causing the delay observed in 2004. Most of the samples collected on 21 September in 2005 reached the pistil primordia stage in all the treatments. Finally, 75-100% of the samples collected at the beginning of October was found at the pistil primordia stage in all the treatments.

Results obtained during this investigation clearly show that irrigation markedly affected the progression of floral differentiation in 'Glohaven' peach (*Prunus persica* L.). It was observed that water stress delayed the differentiation of pistil primordia, thereby prolonging the period during which floral primordia could be subjected to further water stress. Generally, light and severe water stress treatments retard the progression of differentiation. However, optimum irrigation accelerated

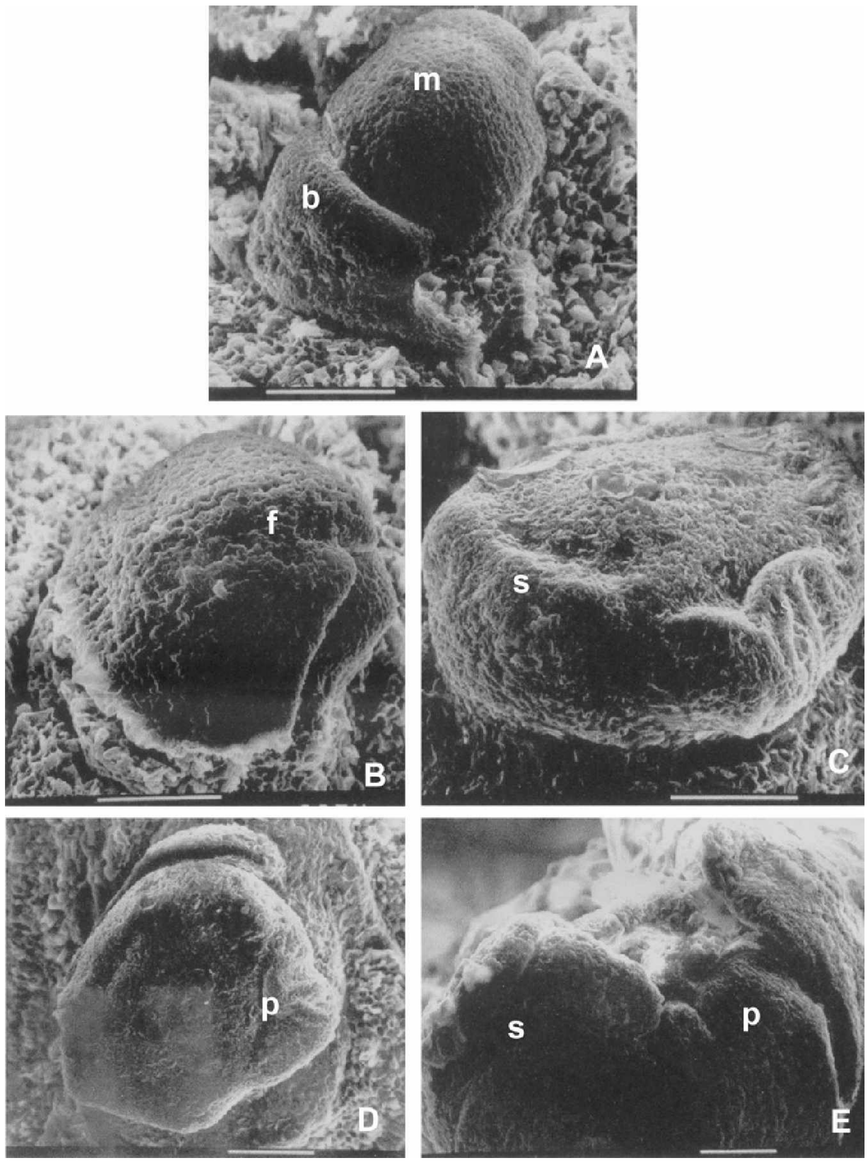

Fig. 1. SEM photographs of 'Glohaven' peach (*Prunus persica* L.) buds, showing developmental changes during flower initiation. A. Initial phase of change from vegetative to reproductive stage, showing rounded meristem (m) and bract (b) primordia. B. Flower (f) primordia enlarged and rounded. C. Sepal (s) primorida in pentagonal whorl. D. Petal (p) primordia differentiate. E. All floral organs differentiated, including sepal (s), petal (p) stamens and pistil. Bar = 50 µm.

flower differentiation considerably. Therefore, at the beginning of September, stamen and pistil had been formed in the buds under optimum irrigation, but under severe water stress, most of the buds were still at the stage of sepal differentiation. When the effect of different periods of drought stress on the development of flower buds of the apricot cv. Guillermo was studied (Alburguerque *et al.* 2003), it was established that with the longer stress period the differentiation time was delayed and their development was slowed. Li (1981) also found that the Japanese apricot flower buds from irrigated trees reached more advanced stages sooner than buds from non-irrigated ones. The present data also show that, when there was a lack of water, the development of flower buds slowed. In addition, when water was not provided again in the next year, flower bud initiation was also delayed.

Table 1. Effect of water stress on the progression of flower bud formation in 'Glohaven' peach (*Prunus persica* L.) during 2004.

Sampling date	Treatment	Flowers (%) at the stage of differentiation of				
		Flower primordia	Sepal primordia	Petal primordia	Stamen primordia	Pistil primordia
2 August	T_1	64.6	31.3	4.1	-	-
	T_2	82.1	14.4	3.5	-	-
	T_3	93.8	6.2	-	-	-
12 August	T_1	37.4	49.7	7.3	5.6	-
	T_2	63.7	28.4	7.9	-	-
	T_3	75.5	21.4	3.1	-	-
22 August	T_1	7.9	50.1	24.6	12.1	5.3
	T_2	44.2	39.6	8.7	7.5	-
	T_3	68.7	24.6	6.7	-	-
1 September	T_1	-	9.1	57.4	17.3	16.2
	T_2	16.3	34.8	36.6	8.7	3.6
	T_3	28.4	46.8	21.1	3.7	-
11 September	T_1	-	-	16.1	31.6	52.3
	T_2	-	12.7	28.4	29.3	29.6
	T_3	4.2	29.3	49.3	13.4	3.8
21 September	T_1	-	-	-	7.6	92.4
	T_2	-	-	5.4	23.1	71.5
	T_3	-	8.3	22.3	21.6	47.8
1 October	T_1	-	-	-	3.2	96.8
	T_2	-	-	-	9.7	90.3
	T_3	-	4.5	7.6	10.1	77.8

Thus, severe water stress treatment retarded the progression, initiation and the developmental stages of flower differentiation considerably. Therefore, at the beginning of September, sepal, petal, stamen and pistil primordia had been formed in the buds under optimum irrigation. However, under severe water stress, most of the buds were still at the stage of sepal and petal differentiation. These facts suggest that decreasing irrigation slows the progression of flower differentiation in this particular variety of peach as observed in other cases by others.

Table 1. Effect of water stress on the progression of flower bud formation in 'Glohaven' peach (*Prunus persica* L.) during 2005.

Sampling date	Treatment	Flowers (%) at the stage of differentiation of				
		Flower primordia	Sepal primordia	Petal primordia	Stamen primordia	Pistil primordia
2 August	T_1	52.3	27.8	19.9	-	-
	T_2	77.8	16.3	5.9	-	-
	T_3	95.7	4.3	-	-	-
12 August	T_1	27.5	42.9	17.4	12.2	-
	T_2	52.6	27.7	19.7	-	-
	T_3	83.2	11.3	5.5	-	-
22 August	T_1	4.6	34.2	19.9	22.8	18.5
	T_2	28.9	41.6	17.6	7.7	4.2
	T_3	59.5	35.2	5.3	-	-
1 September	T_1	-	3.6	38.9	26.1	31.4
	T_2	14.6	29.5	32.1	13.5	10.3
	T_3	25.3	50.6	24.1	-	-
11 September	T_1	-	-	11.3	27.3	61.4
	T_2	-	11.9	19.4	36.1	32.6
	T_3	11.6	30.1	51.2	4.2	2.9
21 September	T_1	-	-	-	2.3	97.7
	T_2	-	-	4.5	19.4	76.1
	T_3	-	12.3	25.7	26.9	35.1
1 October	T_1	-	-	-	-	100
	T_2	-	-	-	6.4	93.6
	T_3	-	6.1	6.9	12.3	74.7

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