Crop Phenology for Irrigated Cantaloupes (*Cucumis melo* L.) in Arizona.

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Abstract

To determine growth and development patterns of irrigated melon (Cucumis melo L.) plants as a function of heat units accumulated after planting (HUAP), as well as to develop a general irrigated cantaloupe plant development model as a function of HUAP. Fifteen commercial melon fields managed by cooperator-growers were selected at five locations in Arizona from 2003 through 2006 to conduct phenological monitoring studies. Basic plant growth and development measurements were collected at phenological stages that corresponded to pre-bloom, early fruit set, early netting, and physiological maturity. Results indicate that in general, growth and development stages of melons occurred with a high degree of consistency as function of HUAP in all sites. Varietal differences did not appear to have large effects on phenological development. Also, a general irrigated cantaloupe plant development model as function of HUAP for all sites and varieties was obtained. The purpose of this phenological baseline or model is to assist growers in predicting and identifying critical stages of growth for crop management purposes. Early bloom occurred at 357 ± 41 HUAP; early fruit set at 619 ± 81 HUAP; early netting at 820 ± 82 HUAP; and physiological maturity (of primary fruit set or crown fruit) was identified to occur at 1297 ± 128 HUAP.

Keywords

melon, *Cucumis melo* L., crop phenology, growth and development, heat units.

Introduction

Arizona melon (*Cucumis melo* L.) production ranks second to California in the United States. In 2003, about 15,200 acres of melons were harvested in Arizona, mainly in Yuma, Maricopa, La Paz, and Pinal Counties. Yield averaged approximately 370 Cwt/acre and the total farm value accrued for AZ amounted to more than $ 87 million dollars (Arizona Agricultural Statistics, 2003).

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Crop development is primarily affected by temperature. Within a range of temperatures below a certain value or threshold, crop development rate often increases proportionally with the temperature (Hodges, 1991). Cantaloupe is a warm-season annual plant that is sensitive to freezing temperatures at any growth stage. Growth is very slow below 60 ^{o}F and optimal from 85 ^{o}F to 95 ^{o}F (Hartz, 1995).

Due to its indeterminate nature, melon plants are very sensitive to environmental conditions; plant will retain or abort fruit in response to current conditions. Accurate prediction of harvest date and developmental stages of a crop has widespread application for improving management of that crop (e.g. fertilization, irrigation, scheduling multiple harvests, pest management activities, labor and machinery management, etc.).

We often can monitor and predict development based on measuring the thermal conditions in the plants environment. Various forms of temperature measurements and units commonly referred to as heat units or growing degree units, have been utilized in numerous studies to predict phenological events for both agronomic and horticultural crops (Baker and Reddy, 2001).

Wurr et al. (2002) stated that to describe crop growth and development there is first the need to determine rate functions for various processes; these include the identification of distinct stages and phases of growth and development, as well as the prediction of duration of developmental phases for given temperature regimes. Hence, the objectives of this study were: 1) to determine growth and development patterns of irrigated melon plants as a function of heat units accumulated after planting (HUAP), and 2) to develop a general irrigated cantaloupe plant development model as a function of HUAP that could be extended as a crop management tool.

Materials and Methods

Eighteen commercial melon fields managed by cooperator-growers were selected at five locations in Arizona from 2003 through 2006 to conduct phenological monitoring studies (Table 1). In all fields, melon seeds were dry planted on 80-inch beds and watered up. Each field was thinned to approximately 12-inch plant spacing (6450 plants per acre). Composite surface 12-inch soil samples were collected from each field prior to any fertilization for complete nutrient analysis. All inputs such as fertilizer, water, disease, and pest control were managed throughout the season on an as-needed basis. In addition, all crop management decisions were made in conjunction with the grower-cooperator.

Arizona Meteorological Network (AZMET) stations that were sited close the experimental sites monitored weather conditions on a daily basis throughout the growing season. The AZMET station is used to determine the hourly temperature values and the heat unit (HU) accumulations (86/55 ºF thresholds) are calculated by a method presented in Baskerville and Emin (1969) and modified by Brown (1989). The daily HU accumulations are summed up from the time of planting and reported as HUAP.

In-season data collection for each treatment was taken from 2m row segments at five randomly selected locations in each field and they include the following basic Plant growth and development measurements: number of vines per plant, number of mainstem nodes, number of fresh flowers on each vine, and length (cm) of each fruiting vine. Also, the number of melons larger than "golf ball" size in two meters segments were counted. Plant measurements were made in regular 14-day intervals and the following growth stages were identified in relation to plant measurement data collection: pre-bloom, early fruit set, early netting, and physiological maturity (Table 2). Statistical analyses were performed on all in-season data collected with statistical procedures consistent with those outlined by Steele and Torrie (1980) and SAS (SAS Institute, 199a and 1999b).

Results and Discussion

In general, growth and development stages of melons occurred with a high degree of consistency as function of HUAP in all sites. Varietal differences did not appear to have large effects on phenological development (Figures 1 to 8).

All variables showed low variability as indicated by the standard deviation values (Table 3). As expected, primary vine length showed the highest variability due to its dynamic growth along the growing season and variation among vines on a common plant as well as plant to plant variation.

A general phonological model for irrigated cantaloupe plant development as function of HUAP for all sites and varieties is shown in table 4. Based on the analyses of the full data set, early bloom occurred at 357 ± 41 HUAP; early fruit set at 619 ± 81 HUAP; early netting at 820 ± 82 HUAP; and physiological maturity was identified to occur at 1297 ± 128 HUAP.

Future work on this project will consist additional data collection and analysis in an effort to develop a consistent and reliable model as well as to take into account new commercial melon varieties.

Acknowledgements

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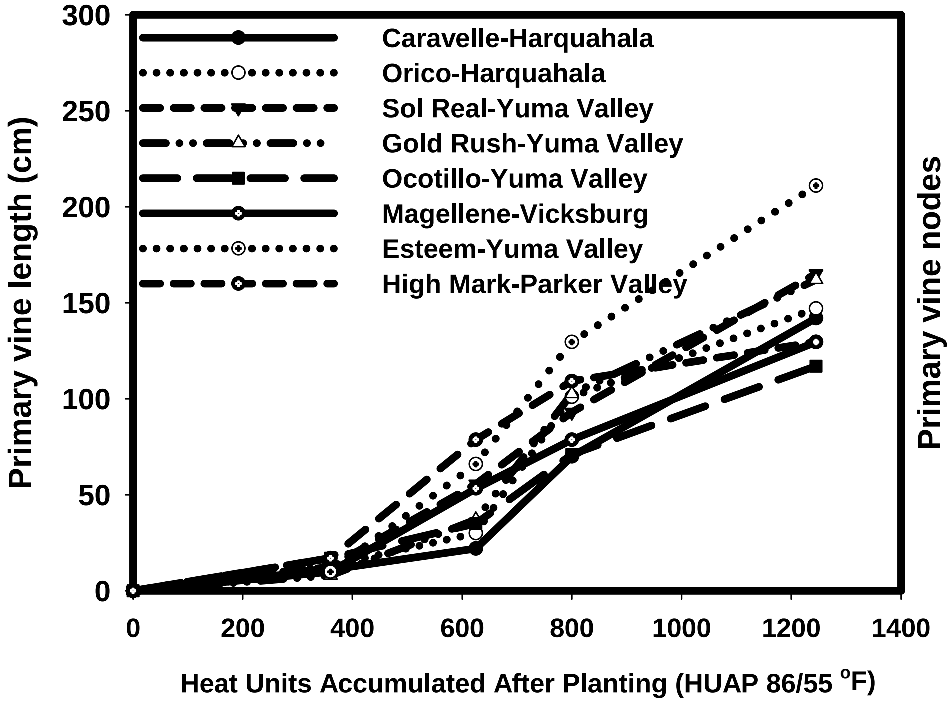
Table 1. Cantaloupe experimental sites; basic agronomic information, Arizona. 2003-2006.

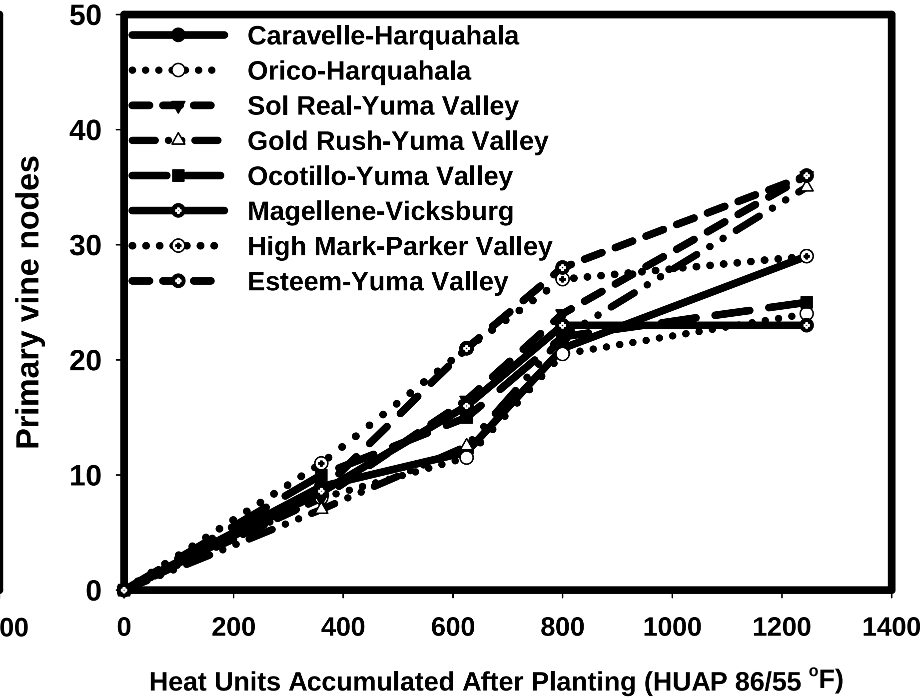
Location	Site	Variety	Wet Date	Irrigation type	Soil type
Yuma Valley	Aaron	Sol Real	2/24/03	Furrow	Silty Clay Loam
	Brazwell	Esteem	3/29/03	Furrow	Clay Loam
	Perriconi	Gold Rush Sol Real Sol Real	3/07/03 2/20/04 3/01/05	Furrow	Clay Loam
	Waymon	Ocotillo	1/26/03	Furrow	Clay Loam
	West Kelly	Impact Gold Rush	2/10/04 2/16/05	Furrow	Clay Loam
	Mason 80	Esteem Gold Rush	3/24/04 2/18/05	Furrow	Silty Clay Loam
	Morton	Esteem	4/02/04	Furrow	Silty Clay Loam
	Newberry	Gold Express	4/02/04	Furrow	Silty Clay Loam
	YVAC	Gold Rush	2/13/04	Furrow	Clay Loam
	Bates	Ocotillo	1/21/05	Furrow	Silty Clay Loam
	Oden farms	Olympic gold	3/02/06	Furrow	Silty Clay Loam
	Amigo farms	Gold Rush	3/05/06	Furrow	Clay Loam
	Andrews farms	Tuscan	4/02/06	Furrow	Clay Loam
Harquahala	3W 15W	Caravelle Orico	2/19/03 3/05/03	Subsurface Drip	Sandy Loam
Parker Valley	CRIT	High Mark	3/15/03	Furrow	Sandy Loam
Vicksburg	I-10 Junction	Magellene	3/06/03	Subsurface Drip	Sandy Loam
Maricopa	MAC	Gold Rush	3/31/04	Subsurface Drip	Clay Loam

Table 2. Cantaloupe experimental sites; phenological sampling dates, Arizona, 2003-2006.

Location	Site	Pre-bloom stage	Early fruit set stage	Early netting stage	Physiological maturity stage
Yuma Valley	Aaron	4/10/03	4/28/03	5/08/03	6/2/03
	Brazwell	4/28/03	5/22/03	6/02/03	6/16/03
	Perriconi	4/10/03	4/28/03	5/15/03	6/02/03
	Waymon	3/18/03	4/10/03	4/28/03	5/28/03
	West Kelly	3/23/04 --------	4/21/04 4/20/05	4/30/04 5/03/05	5/20/04 5/23/05
	Mason 80	4/21/04 --------	5/12/04 4/20/05	5/20/04 5/04/05	6/08/04 5/31/05
	Morton	5/12/04	5/20/04	5/28/04	6/16/04
	Newberry	5/12/04	5/20/04	5/28/04	6/16/04
	YVAC	4/06/04	4/21/04	4/30/04	6/04/04
	Bates	3/16/05	4/20/05	5/04/05	5/31/05
	Oden farms	4/11/06	5/04/06	5/15/06	6/09/06
	Amigo farms	4/13/06	5/06/06	5/16/06	6/10/06
	Andrews farms	4/30/06	5/17/06	6/01/06	6/20/06
Harquahala	3W 15W	4/08/03 4/08/03	5/02/03 5/07/03	5/15/03 5/15/03	6/04/03 6/04/03
Parker Valley	CRIT	4/09/03	5/08/03	5/21/03	6/11/03
Vicksburg	I-10 Junction	4/08/03	4/29/03	5/07/03	5/28/03
Maricopa	MAC	5/10/04	5/25/04	6/15/04	7/29/04



2003 Primary vine length as affected by HUAP.



2003 Primary vine node development as affected by HUAP.

Figure 1. Primary vine length and node development as a function of HUAP for all varieties. Arizona. 2003.

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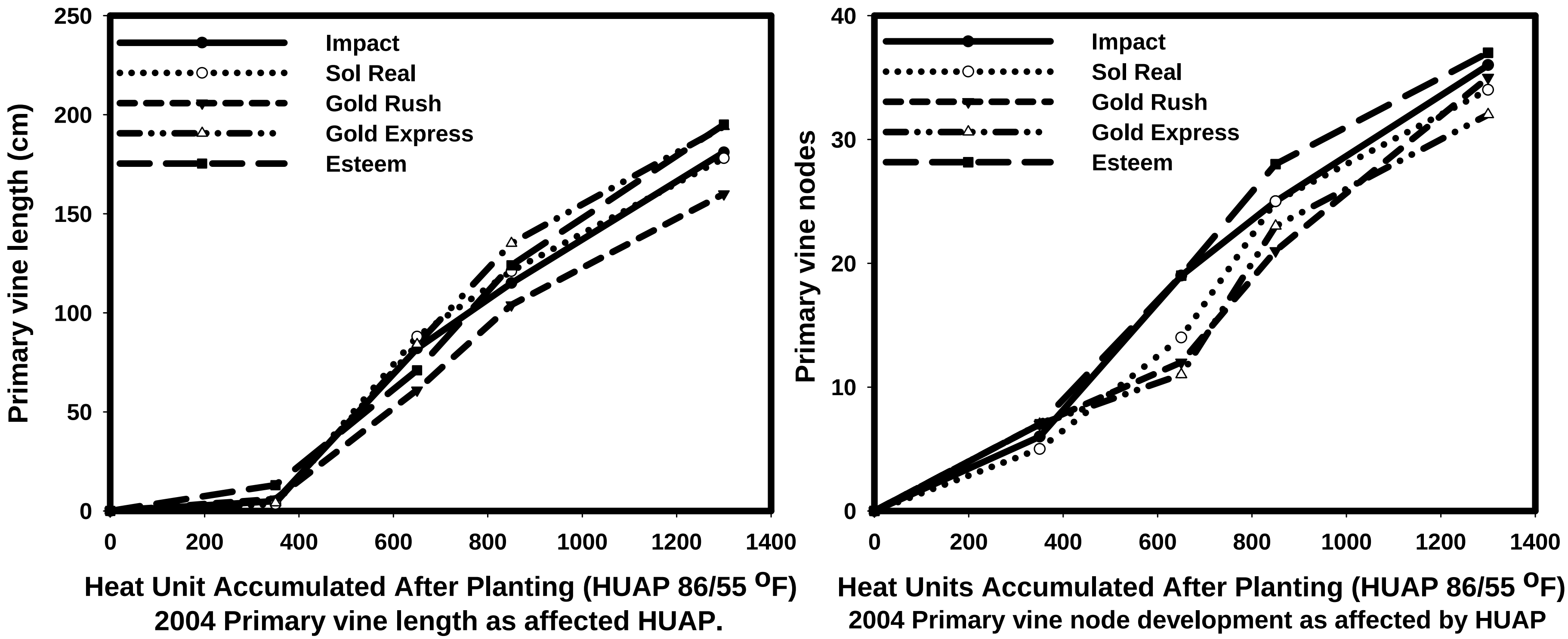
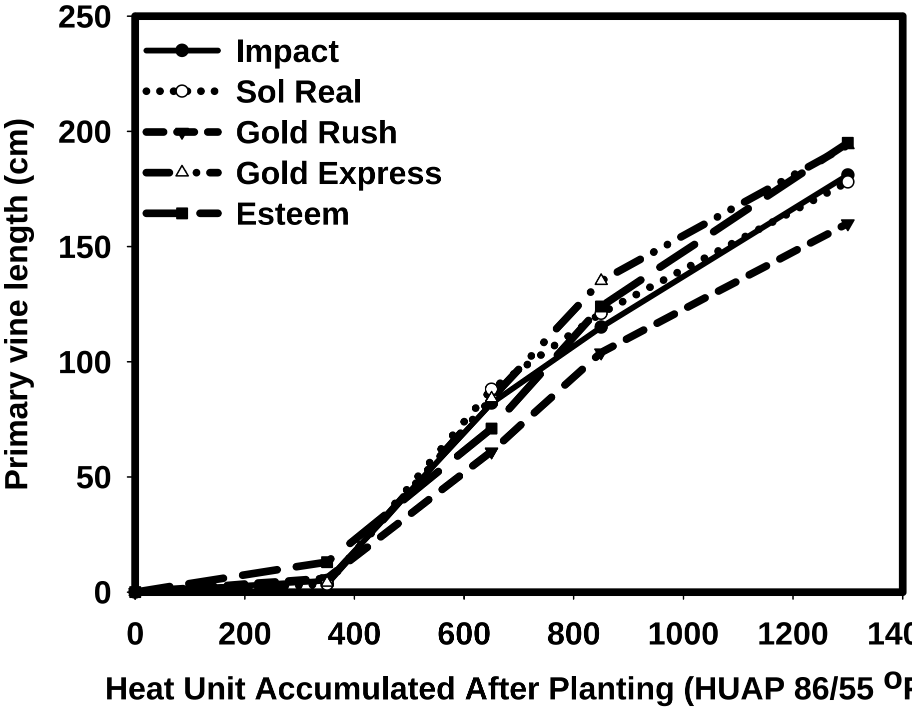
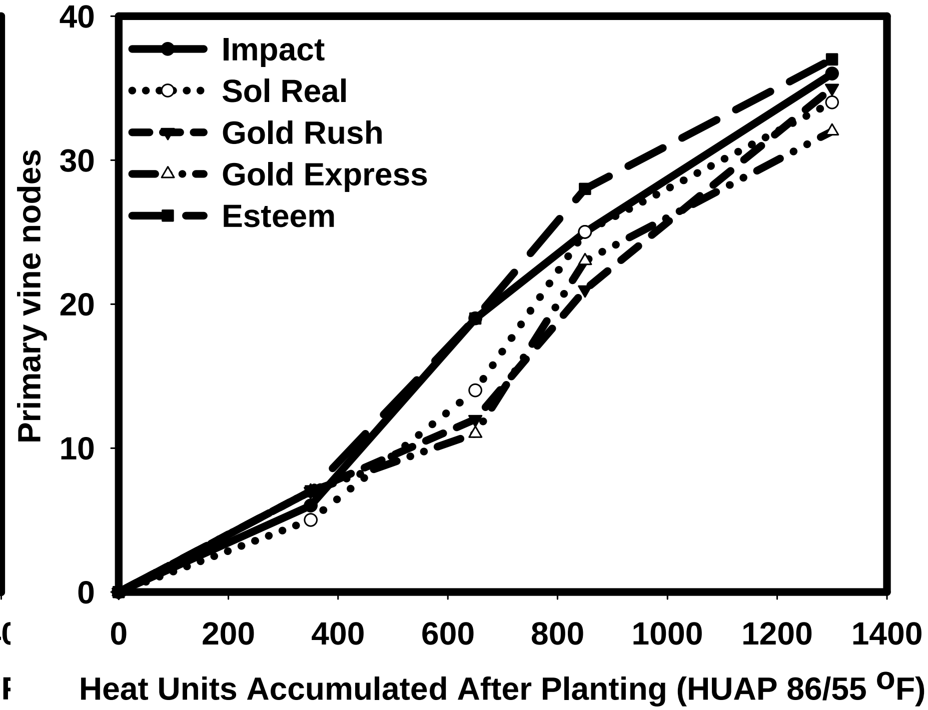


Figure 2. Primary vine length and node development as a function of HUAP for all varieties. Arizona. 2004.

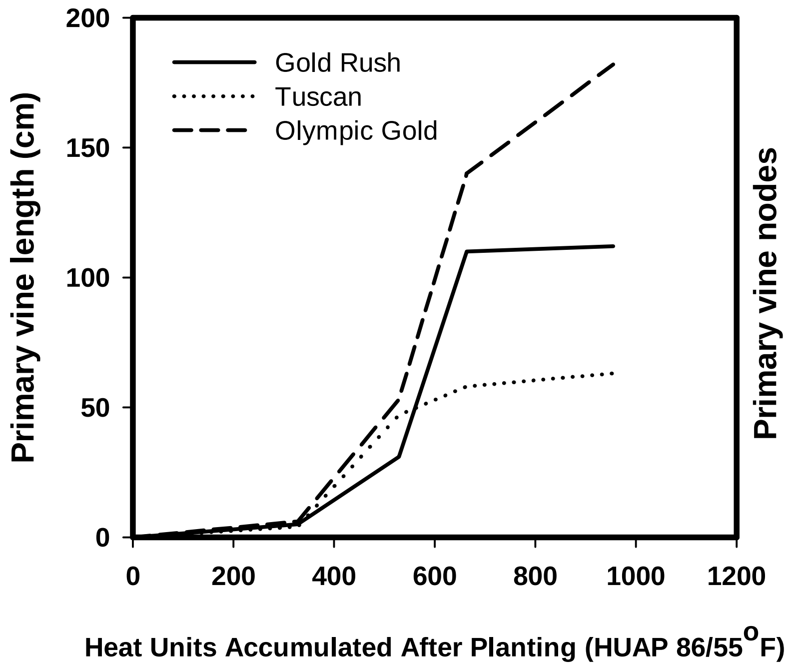


2005 Primary vine length as affected by HUAP.

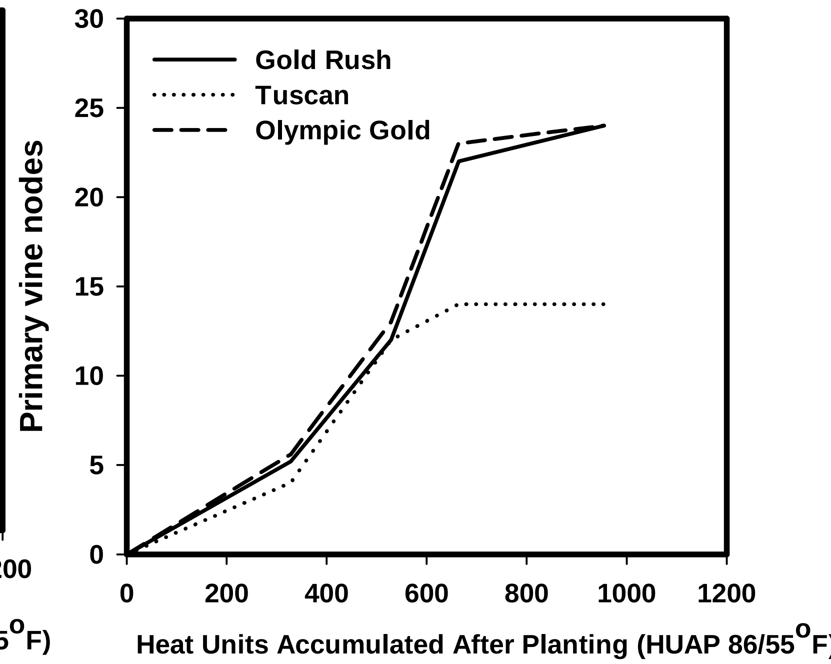


2005 primary vine development node as affected by HUAP.

Figure 3. Primary vine length and node development as a function of HUAP for all varieties. Arizona. 2005.

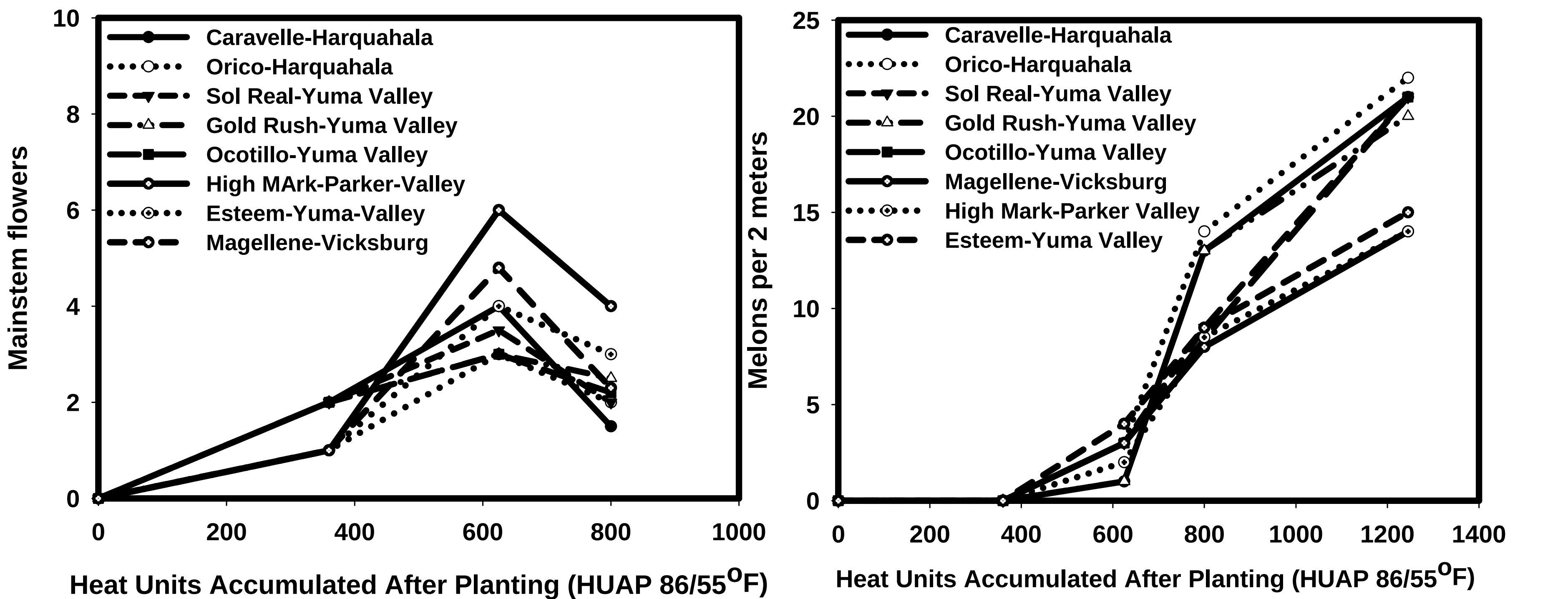


2006 Primary vine length as affected by HUAP



2006 Primary vine length as affected by HUAP

Figure 4. Primary vine length and node development as a function of HUAP for all varieties. Arizona. 2006.



2003 Primary vine flower development as affected by HUAP.

2003 melon fruit set per 2m as affected by HUAP.

Figure 5. Primary vine flower and fruit set development as a function of HUAP for all varieties. Arizona. 2003.

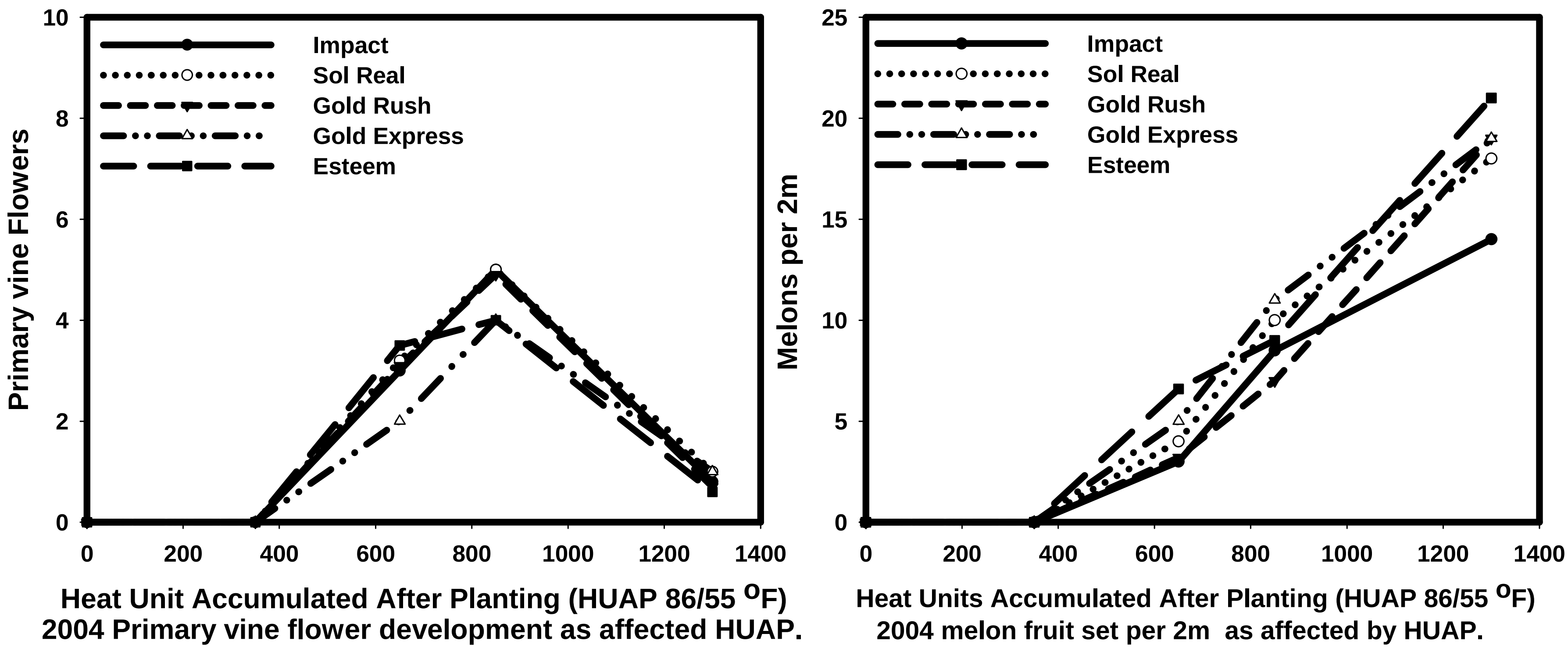
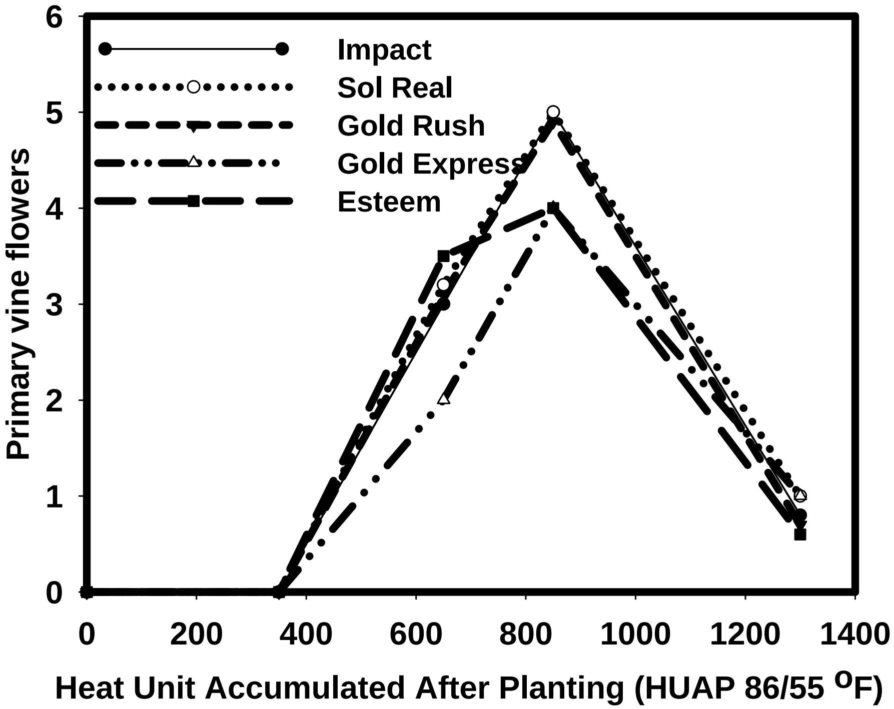
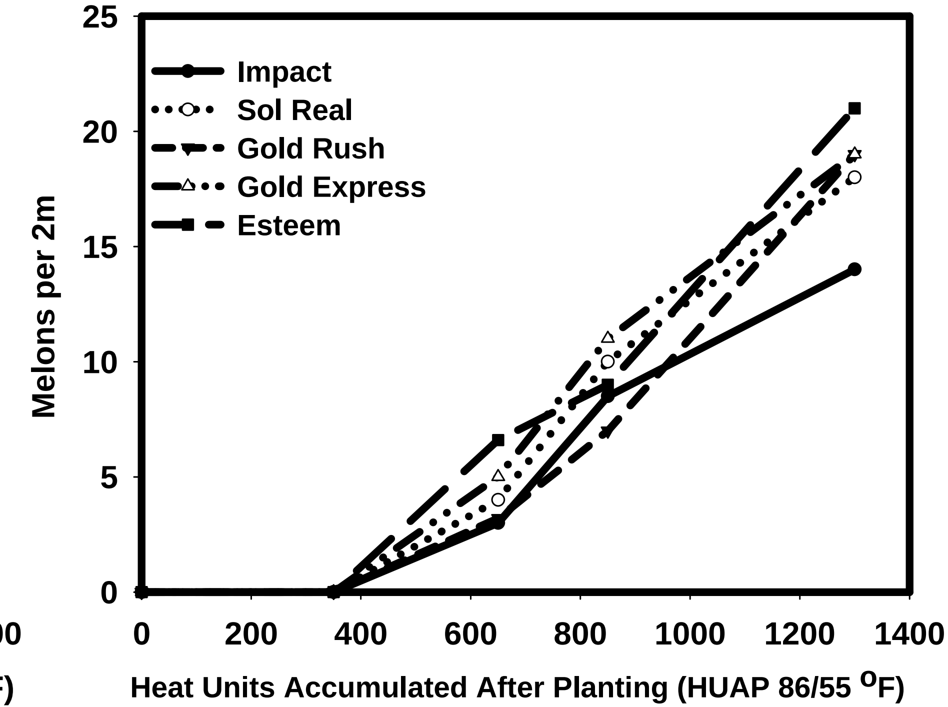


Figure 6. Primary vine flower and fruit set development as a function of HUAP for all varieties. Arizona. 2004.

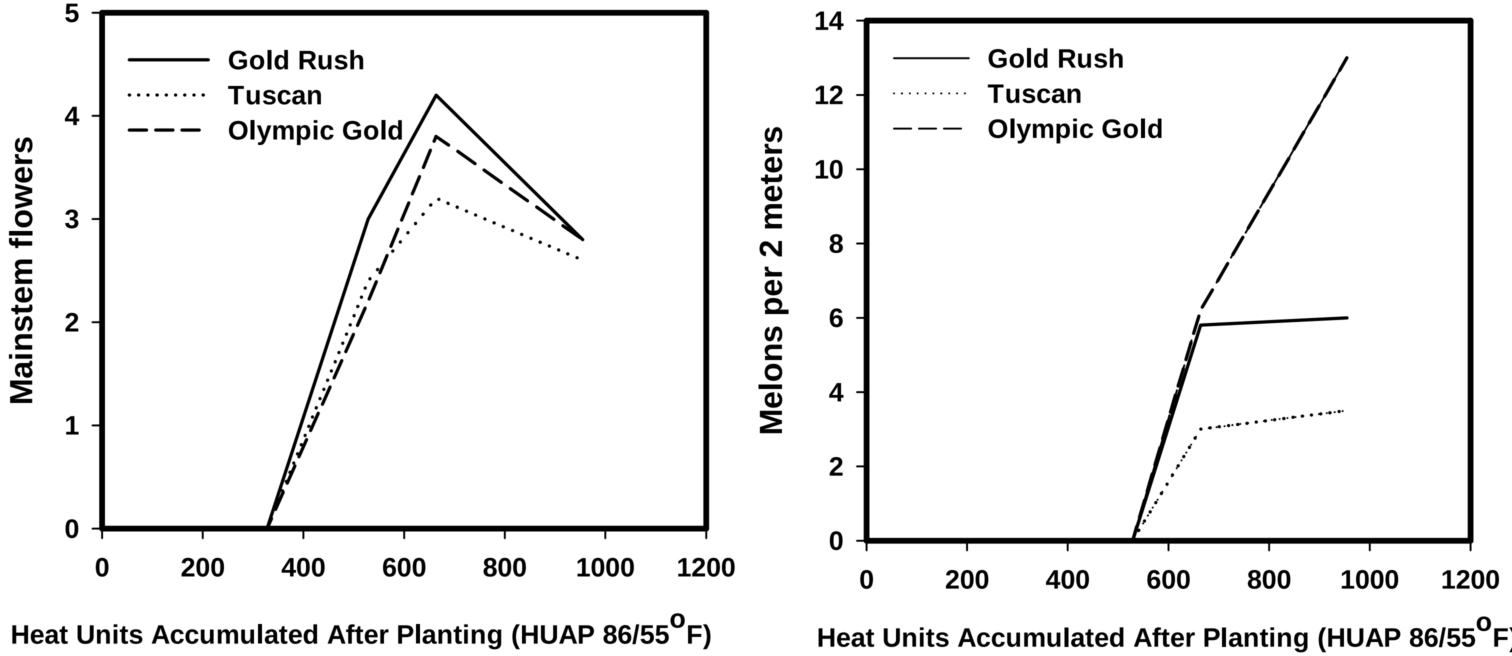


Primary vine flower development as affected by HUAP.



2005 melon fruit set per 2m as affected by HUAP.

Figure 7. Primary vine flower and fruit set development as a function of HUAP for all varieties. Arizona. 2005.



2006 Primary vine flower development as affected by HUAP

2006 Primary vine flower development as affected by HUAP

Figure 8. Primary vine flower and fruit set development as a function of HUAP for all varieties. Arizona. 2006.

Table 3. Average and standard deviation values of cantaloupe basic growth and development variables, as a function of phenological stage. Arizona. 2003-2006.

Phenological Stage	Number of vines	Primary vine nodes	Primary vine length (cm)	Primary vine flowers	Melons in 2 meter
Early Bloom	3 ± 0.5	5 ± 1	4 ± 1	0.2 ± 0.5	0 ± 0
Early fruit set	4 ± 0.5	14 ± 2	32 ± 17	3 ± 1	2 ± 1
Early netting	5 ± 0.4	23 ± 3	71 ± 35	3 ± 1	7 ± 3
Physiological Maturity	5 ± 1	31 ± 6	102 ± 42	0.6 ± 0.9	16± 5

Table 4. Cantaloupe phenological stages as a function of Heat units accumulated after planting (HUAP), Arizona. 2003-2006.

		HUAP (86/55 °F threshold).	
Year	**Phenological Stage**	**Mean**	**Standard Deviation**
2003	Early Bloom	352	45
	Early fruit set	636	64
n = 32	Early netting	815	71
	Physiological Maturity	1265	86
2004	Early Bloom	396	30
	Early fruit set	690	86
n = 20	Early netting	897	74
	Physiological Maturity	1376	41
2005	Early Bloom	344	34
	Early fruit set	601	44
n = 30	Early netting	826	41
	Physiological Maturity	1363	34
2006	Early Bloom	329	19
	Early fruit set	501	66
n = 15	Early netting	688	41
	Physiological Maturity	965	14
Combined	Early Bloom	357	41
	Early fruit set	619	81
n = 97	Early netting	820	82
	Physiological Maturity	1297	128

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