

# Walnut Response to Irrigation

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How important is irrigation management in walnut culture?



West Corning: (2002-2007)

Bearing Chandler orchard

Paradox and NCB rootstock

Hedgerow planting

Maywood sandy loam with stratified soils

One Nelson R5 microsprinkler per tree (0.03 to 0.05 inch/hr)

Cottonwood (2003-2004):

Non-bearing Howard orchard on Paradox Rootstock

Zamora silt loam soil

Nelson R10 microsprinklers

Conventional planting







Campbell Pacific Neutron Probe  
at 8, 18, 30, 42 and 54 inch  
depths



Photo 4

Watermark and Data Logger at 8,  
18, 30, 42 inch depths



Midday SWP

# General strategy for imposing water stress in field trials

Crop Development Stage	Extent of Water Stress			
	Low	Mild	Moderate	High
Root Growth (Feb/Mar)	X			
Bloom (Mar/Apr)	X			
Shoot Growth (Apr/May)	X			
Fruit Sizing (May/June)	X	X		
Kernel Development (Jul/Aug)		X	X	
Bud Differentiation (July/Aug)		X	X	
Root Growth (Aug/Sept)		X	X	
Post-harvest (Oct/Nov)			X	X

# General soil and tree water status in Corning Field Trial

<b>Crop Stress Level</b>	<b>Four-Year Average Applied Water (ac-ft/ac)</b>	<b>Range in Midday SWP (bars)</b>	<b>Soil Tension Ranged from 20 to 80 (centibars)</b>	<b>Soil Tension Ranged from 80 to 200 (centibars)</b>
<b>Low</b>	<b>3.5</b>	<b>- 3 to -7</b>	<b>Apr – Nov</b>	<b>Seldom</b>
<b>Mild</b>	<b>2.4</b>	<b>-3 to -10</b>	<b>Apr - Aug</b>	<b>Sept - Nov</b>
<b>Moderate</b>	<b>1.9</b>	<b>-3 to -12</b>	<b>Apr – mid July</b>	<b>Late July - Nov</b>

# Importance to Shoot Growth



# Effect of irrigation on shoot growth non-bearing Howard Walnut, Cottonwood, 2003

Applied Water (ac-ft/ac)	Average Seasonal Shoot Growth* (feet per season)
1.9	6.4
1.6	5.2
1.2	4.8

\* Average of 16 pruned Shoots per irrigation level

# Effect of irrigation on shoot growth of bearing Chandler Walnut on Paradox, 2002 - 2003

<b>Two-year Average Applied Water (ac-ft/ac)</b>	<b>Average Seasonal Shoot Growth * (feet per season)</b>
3.5 (low stress)	3.5 a
2.4 (mild stress)	3.3 a
2.0 (moderate)	2.4 b

\* Average of about 64 pruned Shoots per irrigation level

# How important is irrigation management to walnut ?

1. Irrigation management affects shoot growth. Generally, less irrigation results in less growth.

# Importance to Walnut Yield



## Effect of irrigation on dry in-shell yield of Chandler walnut on Paradox Rootstock, 2002 – 2005.

<b>Year</b>	<b>Applied Water (ac-ft/ac)</b>	<b>Yield (lbs/acre)</b>	<b>Percent less Yield</b>
<b>2004</b>	<b>3.6 (low)</b>	<b>5046 a</b>	<b>-----</b>
	<b>2.2 (mild)</b>	<b>3770 b</b>	<b>25</b>
	<b>1.9 (mod)</b>	<b>3068 c</b>	<b>39</b>
<b>Four-Year Total</b>	<b>3.5 (low)</b>	<b>21,508 a</b>	<b>-----</b>
	<b>2.4 (mild)</b>	<b>18,066 b</b>	<b>16</b>
	<b>2.0 (mod)</b>	<b>15,737 c</b>	<b>27</b>

## Effect of irrigation on dry in-shell yield of Chandler walnut on NCB Rootstock, 2002 – 2005.

<b>Year</b>	<b>Applied Water (ac-ft/ac)</b>	<b>Yield (lbs/acre)</b>	<b>Percent less Yield</b>
<b>2004</b>	<b>3.6 (low)</b>	<b>3614 a</b>	<b>-----</b>
	<b>2.2 (mild)</b>	<b>2586 b</b>	<b>28</b>
	<b>1.9 (mod)</b>	<b>2044 c</b>	<b>43</b>
<b>Four-Year Total</b>	<b>3.5 (low)</b>	<b>14,323 a</b>	<b>-----</b>
	<b>2.4 (mild)</b>	<b>11,248 b</b>	<b>21</b>
	<b>2.0 (mod)</b>	<b>10,007 b</b>	<b>30</b>

# Effect of water stress on the fate of buds, Chandler walnut grown on Paradox rootstock, 2004.

Applied Water	Reduction in buds that opened (%)	Reduction in floral buds (%)	Reduction of flowers per floral bud (%)	Reduction in nut load (%)
3.6 ac-ft/ac	0 a	0 a	0 a	0 a
2.2 ac-ft/ac	-1 a	-18 a	- 3 a	- 24 a
1.9 ac-ft/ac	-12 b	-12 b	- 9 b	- 31 b



# How important is irrigation management to walnut ?

1. Irrigation management affects shoot growth. Generally, less irrigation results in less growth.
2. **Crop water stress can reduce the number of buds that open and that are fruitful. Results in less nut load and over 40 percent less yield in some seasons.**

# Importance to Walnut Quality



## Effect of irrigation on quality of Chandler Walnut grown on Paradox Rootstock

<b>Year</b>	<b>Applied Water (ac-ft/acre)</b>	<b>Value <sup>1</sup> \$/1000 lbs</b>
<b>2003</b>	<b>3.7 (low)</b>	<b>1116.75 a</b>
	<b>2.2 (mild)</b>	<b>1012.33 b</b>
	<b>1.8 (mod)</b>	<b>959.35 c</b>
<b>Four-Year Avg</b>	<b>3.5 (low)</b>	<b>972.60 a</b>
	<b>2.4 (mild)</b>	<b>927.32 b</b>
	<b>2.0 (mod)</b>	<b>922.95 b</b>

<sup>1</sup> Darker kernel color and higher off-grade main quality parameters affecting walnut value. Significant differences 3 out of 4 years.

# How important is irrigation management to walnut ?

1. Irrigation management affects shoot growth. Generally, less irrigation results in less growth.
2. Crop water stress can reduce the number of buds that open and that are fruitful. Results in less nut load and over 40 percent less yield in some seasons.
3. **Irrigation management often influences walnut value. Darker kernel color and higher off-grade can be more common in water stressed trees.**

## Effect of irrigation on total payment for Chandler Walnut grown on Paradox Rootstock, 2002 - 2005.

<b>Year</b>	<b>Applied Water (ac-ft/acre)</b>	<b>Total Payment (\$/tree)</b>	<b>Percent Less Payment</b>
<b>2004</b>	<b>3.6 (low)</b>	<b>61.76 a</b>	<b>-----</b>
	<b>2.2 (mild)</b>	<b>45.17 b</b>	<b>27</b>
	<b>1.9 (mod)</b>	<b>37.33 b</b>	<b>40</b>
<b>Four-Year Avg</b>	<b>3.5 (low)</b>	<b>66.47 a</b>	<b>-----</b>
	<b>2.4 (mild)</b>	<b>52.50 b</b>	<b>21</b>
	<b>2.0 (mod)</b>	<b>45.51 b</b>	<b>32</b>

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3. Irrigation management often influences walnut value. Darker kernel color and higher off-grade can be more common in water stressed trees.
4. **Improved irrigation management can result in substantially higher payments.**

# Importance to Rootstock Performance



# Effect of irrigation on performance of Paradox and Northern California Black Rootstock, 2002 – 2005

Rootstock	Four-year Average Applied Water (ac-ft/ac)	Four-year Total Dry In-shell Yield (lbs/acre)
Paradox	3.5 (low)	21,508 a
Paradox	2.4 (mild)	18,066 b
<b>Paradox</b>	<b>2.0 (mod)</b>	<b>15,737 c</b>
<b>Black</b>	<b>3.5 (low)</b>	<b>14,323 c</b>
Black	2.4 (mild)	11,248 d
Black	2.0 (mod)	10,007 d

# How important is irrigation management to walnut ?

1. Irrigation management affects shoot growth. Generally, less irrigation results in less growth.
2. Crop water stress can reduce the number of buds that open and that are fruitful. Results in less nut load and over 40 percent less yield in some seasons.
3. Irrigation management often influences walnut value. Darker kernel color and higher off-grade can be more common in water stressed trees.
4. Improved irrigation management can result in substantially higher payments.
5. **If mismanaged, irrigation can negate investments in other walnut culture i.e. hybrid rootstock, etc...**

# Importance of irrigation management to:

- Long term tree health
- Recovering an orchard from a history of deficit irrigation

**THANK YOU!**