EFFECT OF DRIP IRRIGATION MANAGEMENT ON TABLE GRAPE FRUIT QUALITY

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This is the second year of a three year project to evaluate the effect of different drip irrigation management regimes on the production and quality of Thompson Seedless Table Grapes. This concludes the second year of evaluation. A third year of data collection is planned since vine growth and fruit yield differences should be occurring due to the difference of the irrigation regimes.

One of the difficulties experienced with a plot of this size, especially in evaluation of table grape quality, is the variation between pickers and packers. It is anticipated that in 1985 we will attempt to harvest the complete test plot with one packing crew in order to minimize this variation. It is especially important if we look at a three label pack with a high quality number one, a good number one, and a number two label. Differences between packers are tremendous and it is not difficult to obtain statistical differences between packing crews.

METHODS

Thompson Seedless Vines are drip irrigated throughout the growing season at various levels of water use. Water was applied at either 0.5 ET, 1.0 ET, or 1.5 ET during each of three growth stages of the fruit. Grow phase I or (a) was from bud break to fruit set; grow phase II or (b) was from fruit set to veraison; and phase III (c) was from veraison to harvest. A total of 10 treatments were replicated five times in eight vine plots to allow detailed analysis of soil tension, vine

development, fruit yield, and quality. Data collected for this research plot was used in 1984 to help validate the grape vine computer model that represented the only table grape vineyard to be included in this project.

Table grapes were picked and packed by commercial crews and 5 boxes from each plot were held in cold storage for eight weeks. The condition of the fruit was evaluated before shipment to market. Soil moisture was evaluated in two of the five replications with tensiometers placed at 18 inches and 36 inches. The soil moisture tensions through the growing season are listed for each plot in figures one thru ten which represent treatments one through ten. Tables one through six summarize the data collected from the various fruit and vine parameters measured. Tables seven through nine represent water application rates.

RESULTS

Initial cluster counts in April 1984 on the three base treatments of .5 ET, 1.0 ET, and 1.5 ET were not statistically different. Variation was quite prevalent since a three cluster average difference between treatments did not show a statistical difference (table 1).

Berry firmness at harvest and after eight weeks of cold storage were evaluated with a Berry firmness tester. Initially some of the softer or less firm fruit tended to be in plots which had a .5 ET sometime during the growing season. The firmer fruit tended to be in plots that had 1.0 ET or 1.5 ET except that the extremely wet treatment of 1.5 ET had somewhat softer fruit. Stress in the plant later did not seem to soften the fruit as much as a water stress early or during the mid season. After eight weeks of cold storage there was no significant difference in the berry firmness readings (table 2).

VISUAL EVALUATION

At harvest time on, August 7, 1984, vines were visually evaluated for estimated vine growth, berry size, berry and cluster uniformity, cluster tightness, sunburn, and rot damage (table 3). These were generally made on a 0 to 10 rating and were made early in the morning of August 7th. In vine growth the 0.5 ET treatment had significantly less growth while the 1.5 ET treatment had more growth than other treatments.

In estimating berry size, the 0.5 ET and the .5 ET dried down between berry set and veraison had fruit which was estimated to be smaller in berry size. This tends to follow the trend that a water stress occurring from growth to berry set or from berry set to veraison had the greater effect upon berry size.

Berry and cluster uniformity was the poorest at the 0.5 ET where the vines were dried down between berry set and veraison. Water stress between bloom or between start of growth and berry set, or between berry set and veraison had lesser effects upon estimated berry and cluster uniformity. Cluster tightness was greatest in the 0.5 ET although not significantly different from many of the other treatments. Sunburn was higher in the 0.5 ET from a lack of foliage cover. The least amount of sunburn occurred in the 1.5 ET which had an excessive quantity of foliage.

Rot estimates indicated that there was somewhat more rot in the 0.5 ET and lesser amount of rot in other treatments. No effect on water berry was observed, therefore, no evaluations were made for this parameter.

MATURITY DATA

Data was collected on two dates, July 11 and August 1, 1984, berry weight, Degree Brix, percent acid, and Brix to acid ratio, were determined. Initially the 1.5 ET, the .5 ET, between start of growth and berry set and the .5 ET between berry set and veraison had somewhat smaller berry sizes.

The rest of test plots were quite close together. On August 1st, vines that were stressed with 0.5 ET (treatments one thru five) had smaller berry size. Larger berry sizes tended to be when vines received adequate amounts of water during the growing season. Treatment ten with 1.5 ET did have smaller berry size and could be partially due to competition between fruit and foliage. The percent acid and Brix to acid ratio showed considerable variation on both sampling dates.

Harvest data was collected on August 7th and there was no significant difference in total pounds harvested (table 5) due to the wide variation in yield between the test plots. There was no statistical difference in total number of packable pounds of fruit. However, when converted to percent packable there was a significant reduction in the .5 ET of approximately 10 percent. The percentage of culls tended to increase when vines were stressed early from start of growth to berry set, or between berry set and veraison.

Five boxes of fruit from each plot was held in cold storage from August 7 to September 28, 1984. Lids were opened on five boxes of each treatment and fruit ambering, stem condition, overall condition, and brown berries were evaluated.

The amber fruit was in the .5 ET and the greenest fruit was obtained in the moderate to high irrigation plots (table 6). Plots with

0.5 ET during the growing season generally had intermediate amber ratings. Poorest stem condition was observed in the .5 ET and the best stem condition was observed in the treatment eight. Generally the 0.5 ET treatment had the lowest fruit quality when evaluating amber color, stem condition, overall box appearance, and brown berries.

WATER APPLICATION

1984 water applications are in tables seven through nine. Table 7 summarizies the acre inches applied during each phase and at each ET level. Table 8 summarizies the seasonal water applications for the ten treatments. Summaries include acre inches of water applied to harvest and through September 9, 1984. Table 9 ranks the treatment in order of total acre inches of water applied through harvest August 7, 1984 or through September 20, 1984. Effective winter rainfall during the winter of 1983-84 was minimal and would be in addition to the water applied through the drip system.

SUMMARY

1984 data indicates that packable fruit decreases when water stress occurs during phases I or II. Fruit defects were high when less than 16 inches of water was applied, and a water stress occurred in phases I or II. A water stress in phase III or in phase II followed by 1.5 ET application had minimal effect on fruit quality.

These test plots demonstrate that adequate crops can be obtained with 16-19 acre inches of water applied from start of growth through harvest. Application rate of 21 through 28 acre inches of water did not result in improved table grape quality. Additional statistical analyses need to be run on this data correlating data to water application rates.

Seasonal application rates were from 11.3 inches to 33.9 acre inches when post harvest irrigation is added in. Seasonal water rates are shown since the phase III ET's were maintained after harvest until September 20, 1984 cutoff.

Table 1. Drip Irrigation Trial - 1984

Cluster Counts

Treat	ET Phase I/	II/	III/	April 1984	
1	.5	.5	.5	19.8 a	
7	1.0	1.0	1.0	17.7 a	
10	1.5	1.5	1.5	16.6 a	NS 1/

1/ means separation by Duncan's Multiple Range Test.
.05 NS = not significant
I/ Start of growth to berry set
II/ Berry set to veraison
III/ Veraison to harvest

Table 2. Drip Irrigation Trial - 1984

Berry Firmness Data

Treat	ET Phase I/	II/	III/	Pre Harvest 8/2 grams	1/ 9/28 grams
1	.5	.5	.5	413 c	354 a
2	1.0	1.5	.5	471 a b	399 a
3	.5	1.0	1.0	458 a b c	398 a
4	1.0	.5	1.0	405 c	366 a
5	1.0	1.0	.5	441 b c	376 a
6	1.0	.5	1.5	449 a b c	346 a
7	1.0	1.0	1.0	503 a	390 a
8	1.0	1.5	1.0	501 a	405 a
9	1.0	1.0	1.5	485 a b	399 a
10	1.5	1.5	1.5	461 a b c	409 a
				.05 2/	.05 2/

I/ Start of growth to berry set
II/ Berry set to veraison
III/ Veraison to harvest

1/ = after 8 weeks cold storage
2/ = mean separation by Duncan's Multiple Range Test

Table 3. Drip Irrigation Trial - 1984

Visual Evaluation Data

At Harvest August 7, 1984

	ET Phase			Estimate 1/ Vine Growth	Estimate 2/ Berry Size	Estimate 3/ Berry/Cluster Uniformity	Estimate 4 Cluster Tightness	Estimate 5/ Sunburn	Estimate 6/ Rot
	I/	II/	III/						
1	.5	.5	.5	3.6 d	6.1 c	4.8 c	7.6 a	.6 b	6.8 a
2	1.0	1.5	.5	7.3 a b c	7.6 a b	6.4 a b	6.6 a b	1.2 a b	2.4 c d
3	.5	1.0	1.0	6.6 b c	8.8 a	7.3 a	7.1 a b	1.4 a b	3.1 b c
4	1.0	.5	1.0	5.6 c	6.6 b c	5.4 b c	7.1 a b	1.6 a b	4.4 b
5	1.0	1.0	.5	7.5 a b c	8.0 a	6.2 a b c	6.0 b	1.0 a b	1.4 c d
6	1.0	.5	1.5	6.7 b c	8.0 a	7.2 a	7.2 a b	1.0 a b	1.4 c d
7	1.0	1.0	1.0	8.7 a b	8.5 a	7.3 a	6.6 a b	1.3 a b	1.0 d
8	1.0	1.5	1.0	8.7 a b	8.4 a	6.8 a b	6.0 b	1.1 a b	1.2 c d
9	1.0	1.0	1.5	7.0 a b c	7.9 a	6.9 a b	6.6 a b	1.0 a b	2.4 c d
10	1.5	1.5	1.5	9.1 a	7.9 a	6.4 a b	6.0 b	1.7 a	1.0 d
				.05 7/	.05 7/	.05 7/	.05 7/	.05 7/	.05 7/

1/ 1 = Least Growth; 10 = Excessive Growth 2/ 0 = Small Berry; 10 = Large Berry
3/ 1 = Poor Uniformity; 10 = Good Uniformity 4/ 0 = Loose; 10 = Tight
5/ 0 = Sunburn; 10 = No Sunburn 6/ 0 = No Rot; 10 = Rot
7/ Mean separation by Duncan's Multiple Range Test

I/ = Start of Growth to Berry Set II/ = Berry Set to Veraison III/ = Veraison to Harvest

Table 4. Drip Irrigation Trial - 1984

Maturity Data

Sample Dates 7/11/84 and 8/1/84

	ET Phase			Berry Wt. Grams		°Brix	
				Date		Date	
	I/	II/	III/	7/11	8/1	7/11	8/1
1	.5	.5	.5	3.42 c	4.89 a b	12.0 a b	18.3 a b
2	1.0	1.5	.5	3.63 a b	4.84 b	11.7 b	17.7 b c
3	.5	1.0	1.0	3.57 b c	5.06 a b	11.6 b	17.5 b c
4	1.0	.5	1.0	3.59 a b c	4.98 a b	12.3 a b	18.6 a
5	1.0	1.0	.5	3.65 a b	4.97 a b	11.6 b	17.9 a b c
6	1.0	.5	1.5	3.78 a	5.10 a	12.3 a b	18.3 a b
7	1.0	1.0	1.0	3.63 a b	5.02 a b	11.9 a b	17.9 a b c
8	1.0	1.5	1.0	3.69 a b	5.10 a	11.5 b	17.2 c
9	1.0	1.0	1.5	3.67 a b	5.13 a	11.8 a b	17.9 a b c
10	1.5	1.5	1.5	3.66 a b	4.90 a b	12.6 a	18.2 a b
				.05 1/	.05 1/	.05 1/	.05 1/

I/ = Start of Growth to Berry Set
II/ = Berry Set to Veraison
III/ = Veraison to Harvest
1/ = mean separation by Duncan's Multiple Range Test.

Treat	ET Phase			% Acid		°B/% Acid	
				Date		Date	
	I/	II/	III/	7/11	8/1	7/11	8/1
1	.5	.5	.5	1.64 c	.64 c	7.4 a	29.5 a
2	1.0	1.5	.5	2.02 a	.77 a	5.8 b	23.1 c
3	.5	1.0	1.0	1.99 a	.74 a b	5.8 b	23.5 c
4	1.0	.5	1.0	1.71 b c	.65 b c	7.4 a	28.6 a b
5	1.0	1.0	.5	1.96 a	.74 a b	6.0 b	24.2 c
6	1.0	.5	1.5	1.64 c	.70 a b c	7.6 a	26.4 a b c
7	1.0	1.0	1.0	1.91 a b	.74 a b	6.2 a b	24.3 c
8	1.0	1.5	1.0	1.95 a b	.72 a b c	5.9 b	24.5 b c
9	1.0	1.0	1.0	1.80 a b c	.70 a b c	6.8 a b	25.7 a b c
10	1.5	1.5	1.5	1.71 b c	.68 a b c	7.4 a	27.2 a b c
				.05 1/	.05 1/	.05 1/	.05 1/

I/ = Start of Growth to Berry Set
II/ = Berry Set To Veraison
III/ = Veraison to Harvest
1/ = Mean separation by Duncan's Multiple Range Test

Table 5. Drip Irrigation Trial - 1984

Harvest Yield Data

Replications 1 - 4

Treat	ET Phase I/	ET Phase II/	ET Phase III/	Total Fruit lbs.	Total Packable lbs.	% Packable	% Culls	% #1	% #2
1	.5	.5	.5	217 a	166 a	74 b	26 a	61 b	24 a
2	1.0	1.5	.5	177 a	157 a	89 a	11 b	58 b	29 a
3	.5	1.0	1.0	240 a	200 a	84 a	16 b	68 a b	22 a
4	1.0	.5	1.0	202 a	172 a	86 a	14 b	65 a b	23 a
5	1.0	1.0	.5	171 a	155 a	91 a	9 b	77 a b	16 a
6	1.0	.5	1.5	206 a	185 a	90 a	10 b	74 a b	18 a
7	1.0	1.0	1.0	167 a	149 a	90 a	10 b	83 a	8 a
8	1.0	1.5	1.0	243 a	220 a	90 a	10 b	76 a b	14 a
9	1.0	1.0	1.5	228 a	200 a	85 a	15 b	70 a b	20 a
10	1.5	1.5	1.5	187 a	166 a	89 a	11 b	69 a b	22 a
				NS 1/	NS 1/	.05 1/	.05 1/	.05 1/	NS 1/

I/ = Start of Growth to Berry Set; II/ = Berry set to Veraison; III/ = Veraison to Harvest
1/ = Mean separation by Duncan's Multiple Range Test NS = not significant

Table 6. Drip Irrigation Trial - 1984

Cold Storage Data

In August 7, 1984 -- Out September 28, 1984

Treat	ET Phase I/	ET Phase II/	ET Phase III/	Amber 1/ Fruit	Stem 2/ Condition	Overall 3/ Box	Brown 4/ Berries
1	.5	.5	.5	3.6 d	5.3 c	5.7 c	2.0 a
2	1.0	1.5	.5	5.3 b c	5.8 a b c	6.0 b c	1.1 a b c
3	.5	1.0	1.0	5.8 a b c	6.5 a b	6.8 a b	1.1 a b c
4	1.0	.5	1.0	4.7 c	6.3 a b c	6.2 a b c	1.1 a b c
5	1.0	1.0	.5	5.5 a b c	6.1 a b c	6.3 a b c	1.1 a b c
6	1.0	.5	1.5	4.6 c	5.9 a b c	6.1 a b c	1.6 a b c
7	1.0	1.0	1.0	5.8 a b c	5.6 b c	6.0 b c	1.2 a b c
8	1.0	1.5	1.0	6.1 a b	6.8 a	7.1 a	1.0 b c
9	1.0	1.0	1.5	5.7 a b c	6.4 a b	5.6 c	1.8 a b
10	1.5	1.5	1.5	6.6 a	6.0 a b c	6.4 a b c	.8 c
				.05 5/	.05 5/	.05 5/	.05 5/

1/ 0= yellow; 10 = green 2/ 0= stem dry; 10 = stems green
3/ overall box appearance 0= poor; 10 = good 4/ brown berries 0= green 10 = brown 5/ mean separation by Duncan's Multiple Range Test.
I/=start of growth to berry set; II/= berry set to veraison; III/ veraison to harvest

Table 7. WATER APPLICATION 1984

Growth Stage	Phase	Acre Inches/Acre 0.5 ET	1.0 ET	1.5 ET
Start of Growth to Berry Set	I	4.34	8.68	13.02
Berry Set to Veraison	II	2.85	5.69	8.54
Veraison to Harvest	III	2.21	4.41	6.62
Harvest to 9/20/84	IV	1.89	3.78	5.67

Table 8. WATER APPLICATION PER TREATMENT DURING
Phases I thru IV - 1984 Season

Treat	ET Phase I/	ET Phase II/	ET Phase III/& IV/	Acre Inches Phase I	Acre Inches Phase II	Acre Inches Phase III	Acre Inches Harvest	Acre Inches Phase IV	Total Season
1.	.5	.5	.5	4.34	2.85	2.21	9.40	1.89	11.29
2.	1.0	1.5	.5	8.68	8.54	2.21	19.43	1.89	21.32
3.	.5	1.0	1.0	4.34	5.69	4.41	14.44	3.78	18.22
4.	1.0	.5	1.0	8.68	2.85	4.41	15.94	3.78	19.72
5.	1.0	1.0	.5	8.68	5.69	2.21	16.58	1.89	18.47
6.	1.0	.5	1.5	8.68	2.85	6.62	18.15	5.67	23.82
7.	1.0	1.0	1.0	8.68	5.69	4.41	18.78	3.78	22.56
8.	1.0	1.5	1.0	8.68	8.54	4.41	21.63	3.78	25.41
9.	1.0	1.0	1.5	8.68	5.69	6.62	20.99	5.67	26.66
10.	1.5	1.5	1.5	13.02	8.54	6.62	28.18	5.67	33.85

Table 9. SEASONED WATER APPLICATION
DRIP IRRIGATION TRIAL 1984

Treat No.	ET Phase			Phases I thru III Ac. In.	Treat No.	ET Phase			Phases I thru IV Ac. In.
1.	0.5	0.5	0.5	9.40	1.	0.5	0.5	0.5	11.29
3.	0.5	1.0	1.0	14.44	3.	0.5	1.0	1.0	18.22
4	1.0	0.5	1.0	15.94	5.	1.0	1.0	0.5	18.47
5	1.0	1.0	0.5	16.58	4.	1.0	0.5	1.0	19.72
6	1.0	0.5	1.5	18.15	2.	1.0	1.5	0.5	21.32
7	1.0	1.0	1.0	18.78	7.	1.0	1.0	1.0	22.56
2	1.0	1.5	0.5	19.43	6.	1.0	0.5	1.5	23.82
9.	1.0	1.0	1.5	20.99	8.	1.0	1.5	1.0	25.41
8.	1.0	1.5	1.0	21.63	9.	1.0	1.0	1.5	26.66
10.	1.5	1.5	1.5	28.18	10.	1.5	1.5	1.5	33.85

fig 1. ET 0.5-0.5-0.5

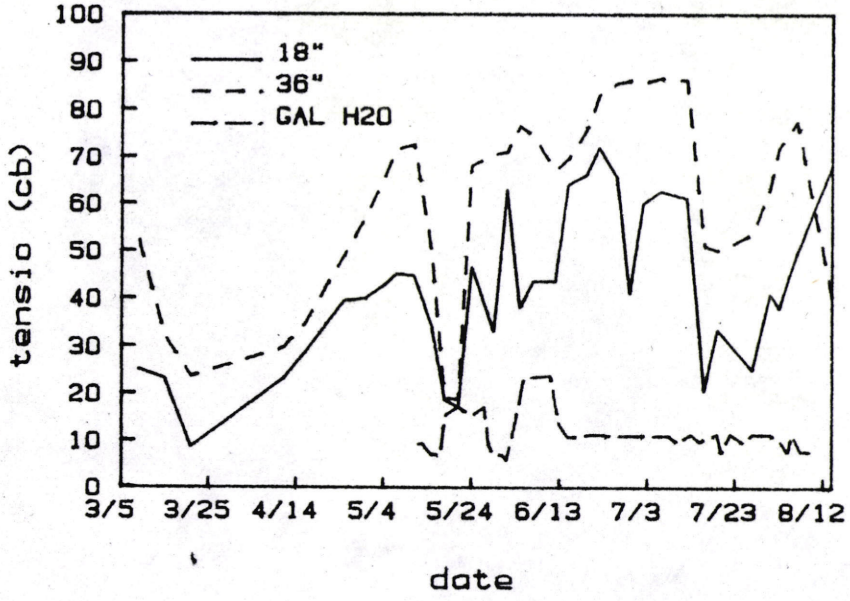


fig 2. ET 1.0-1..5-0.5

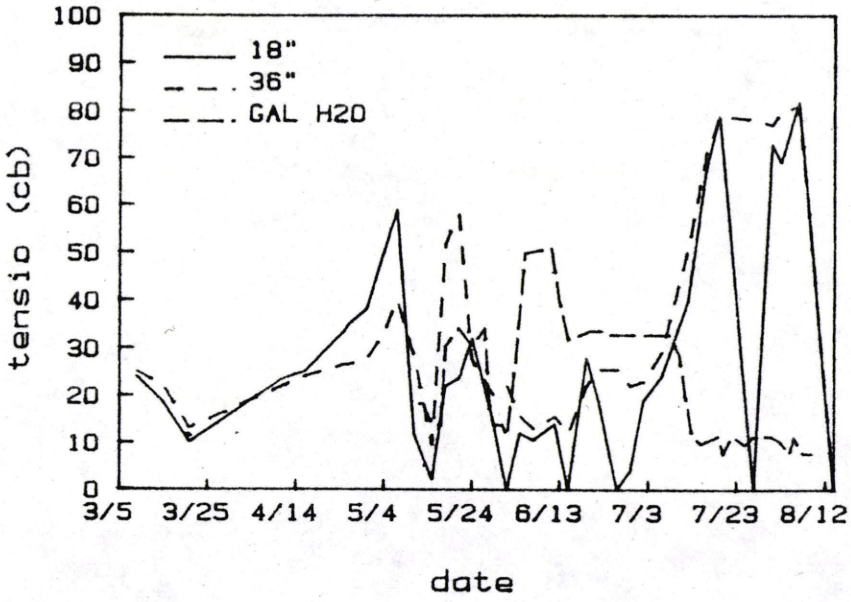


fig 3. ET 0.5-1.0-1.0

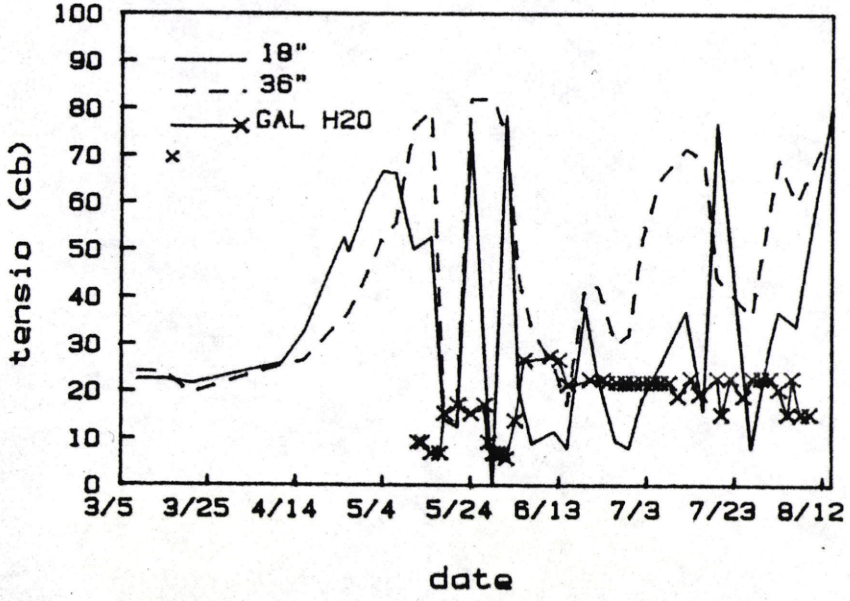


fig 4. ET 1.0-0.5-1.0

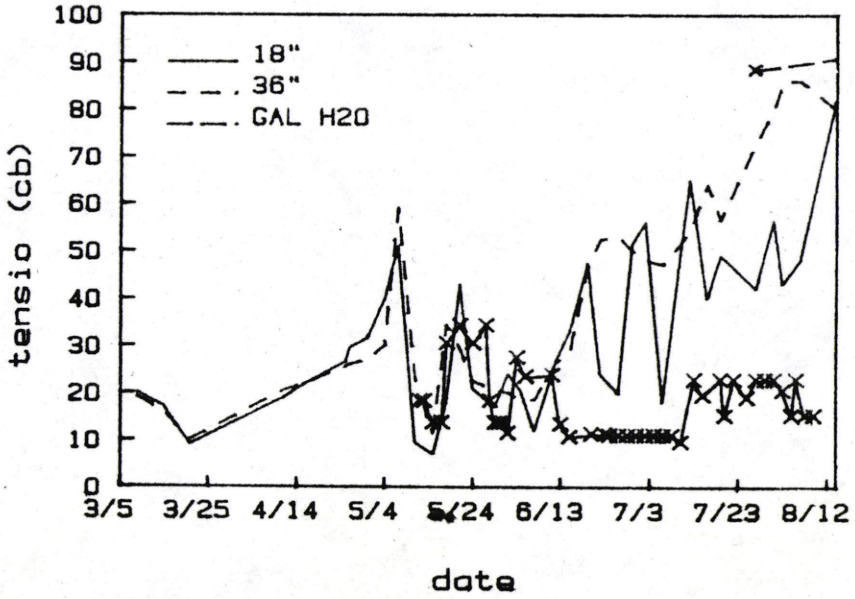


fig 5. ET 1.0-1.0-0.5

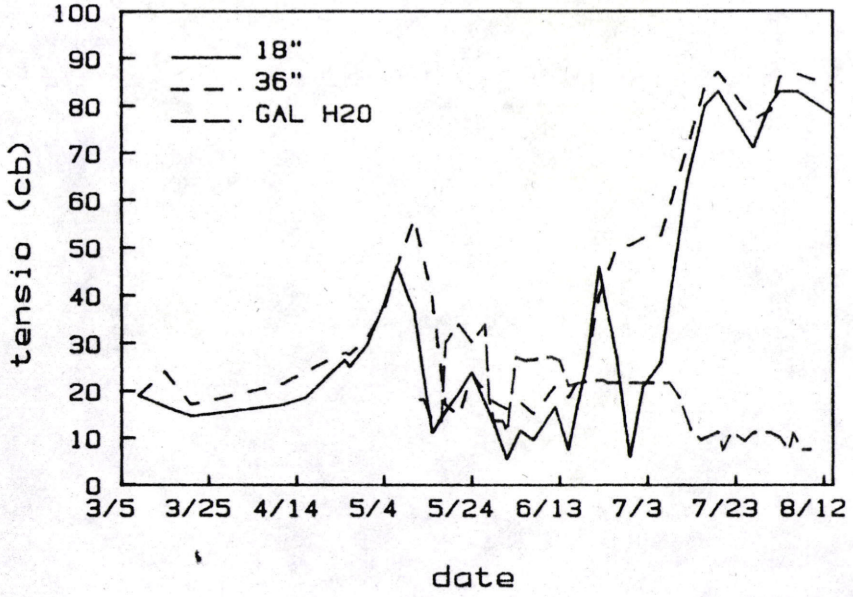


fig 6. ET 1.0-0.5-1.5

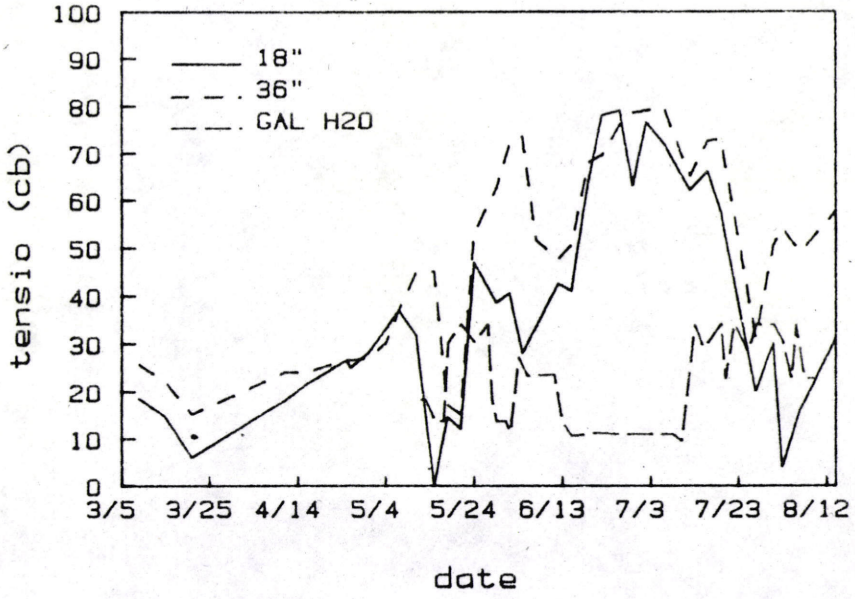


fig 7. ET 1.0-1.0-1.0

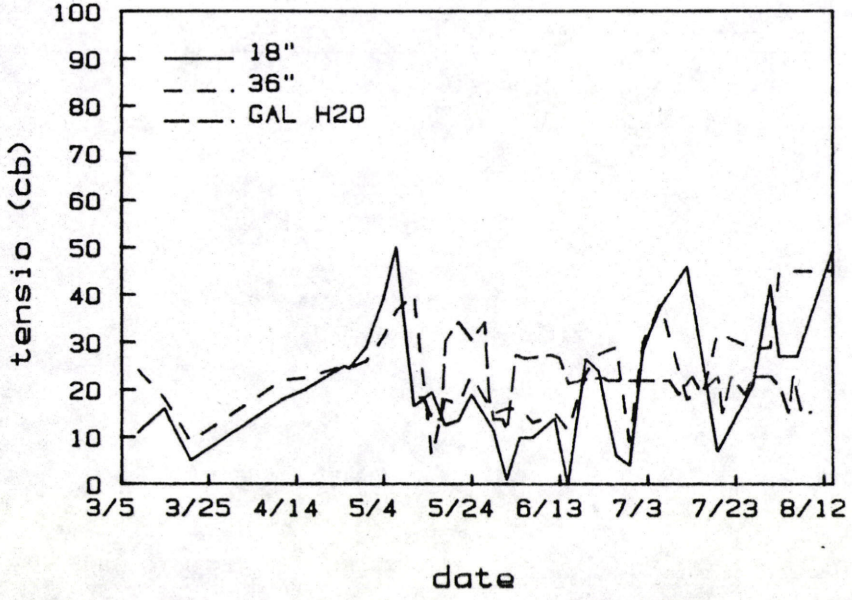


fig 8. ET 1.0-1.5-1.0

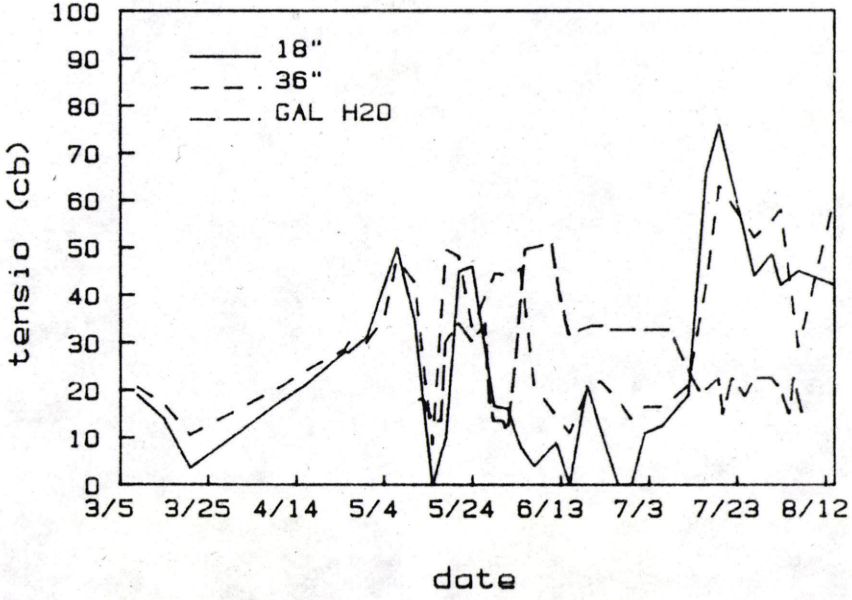


fig 9. ET 1.0-1.0-1.5

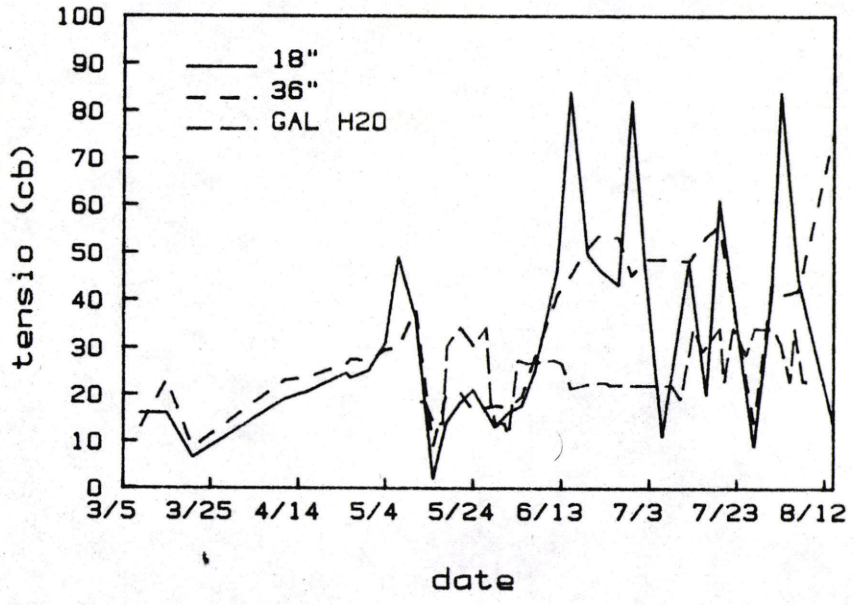
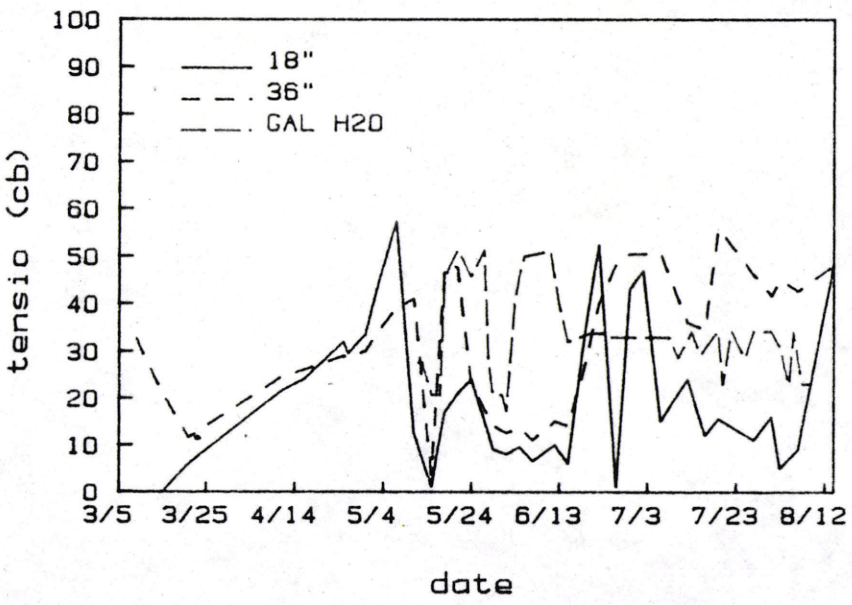


fig 10. ET 1.5-1.5-1.5



Thompson Seedless - Effect of Drip Irrigation Management on Table Grape Quality

TEST ESTABLISHED MARCH 1983 Pandol Ranch (Map Rev 1/29/85)

TREATMENT	COLOR CODE	ET PHASE I	ET PHASE II	ET PHASE III
1	WY	0.5	0.5	0.5
2	WR	1.0	1.5	0.5
3	WB	0.5	1.0	1.0
4	W	1.0	0.5	1.0
5	Y	1.0	1.0	0.5
6	R	1.0	0.5	1.5
7	B	1.0	1.0	1.0
8	BY	1.0	1.5	1.0
9	BR	1.0	1.0	1.5
10	YR	1.5	1.5	1.5

