A Study on Some Treatments Which Mitigate Drought Effects on Barrani Grapevines cv.

I.E. Abd El-Rhman

Desert research center.Min.of Agric. and land Reclamation, Egypt.

Abstract: This investigation was carried out during two successive seasons 2008&2009 to study the effect of (pruning, vapor-guard at 4,6%, paraffin wax at 8,10 % (as antitranspirants), PP$_{333}$ at 500,1000 ppm and CCC at 500,1000 ppm (as growth retardants)) treatments on mitigate drought effect on vegetative growth, yield and fruit quality of Barrani grapevines. Pruning treatments at two methods had in significant effect on vegetative growth, yield and fruit quality compared with other treatments. All other treatments i.e. vapor-guard at 4 and 6 %, paraffin wax at 8 and 10 %, CCC at two rats 500 and 1000 ppm and PP$_{333}$ at two rats 500 and 1000 ppm inhibited vegetative growth .On the other hand, all spraying treatments with vapor-guard at 4 and 6%, paraffin wax at 8 and 10%, CCC at two rats 500 and 1000ppm and PP$_{333}$ at two rate 500 and 1000ppm increased yield and fruit quality and increased proline accumulation in leaves of Barrani grapevines.CCC and PP$_{333}$ treatments sprayed at 500 or 1000 ppm gave the highest values of fruit physical and chemical properties. In addition, CCC spraying at 500ppm gave the highest values of total sugars percentage as compared with other treatments.

Key words: grapevines, drought, water stress, pruning, antitranspirants, paraffin wax, cycocel CCC, paclopatrazol PP$_{333}$, vegetative growth, yield, fruit quality.

INTRODUCTION

The north western coastal zone of Egypt is one of the arid areas, depended on the rains as the main source of water either for human daily use or for agriculture. Barrani grapevine is one of two cultivar which was obtained in Matrouh Governorate especially in Sedi Barrani; grapevines in this area were not conducted to any kind of regular management except elimination of the dry arms or cutting off the one year old shoots just for shorting, not as a regular pruning or for architecture.

Drought is one of the most important factors limiting crop yield and quality worldwide, especially in regions with a climate of the Mediterranean type. In many regions, viticulturists rely on irrigation water during drought periods. However, there is considerable controversy concerning the positive and negative effects of grapevine irrigation on growth as well as on must and wine quality. In contrast, a mild water stress imposed through deficit irrigation may reduce vine vigor and competition for carbohydrates by the growing tips, and may increase the berry and wine quality Matthews and Anderson$^{[1,2]}$

In most vineyards, the management of water deficit by soil preparation practices, scion and rootstock selection, or the presence of cover crops is used to manipulate shoot vigor and canopy characteristics. In cropping areas prone to frequent severe drought, where irrigation is required, water supplies can be managed according to the predicted changes in soil water status with time. These practices are called regulated deficit irrigation or partial root drying Dry and Loveys$^{[3]}$, McCarthy et al$^{[4]}$ and Santos et al$^{[5]}$.

Spraying Washington navel and Succary orange tree by magnesium carbonate and kaolin as antitranspirants enhanced the leaf mineral contents, yield and fruit quality. So, spraying trees by kaolin at 4% once at early March is the promising treatment since it increased yield by about 35.4 and 27.5% for Washington navel orange and by 25.9 and 36.9 for Succary orange respectively. Spraying ant transpiration (vapor-guard) 3-7 week before harvesting increased stomata resistance of tagged Apricot leaves 14 day after treatment by 54-62% compared with untreated leaves Saleh et al$^{[6]}$ Ben and Greenblat$^{[7]}$. The influence of PP$_{333}$ was intermediate between that of CCC and SADH. The concentration of the chemicals did not make any clear difference. CEPA increased the inhibition of growth. The total yield of bearing of c.v. Clapp's Favorite was highest on trees sprayed with CCC or SADH, but there was a clear tendency to biennial bearing. The total yield of trees sprayed with PP$_{333}$ was about 100% higher than that of control trees.

Corresponding Author: Abd EL-Rhman, I.E, Desert research center.Min.of Agric. and land Reclamation, Egypt
The total yield of c.v. Beurre Hardy in comparison with control was as follows: sprayed with CCC - 78–147% higher, sprayed with SADH - 35–78% higher, and sprayed with PP333 - 23–44% higher, Jaumien et al.[8].

Water stress also induced the accumulation of other compatible solutes such as glycerol, sugar, betaines and proline. The accumulation of free proline in plants may be part of a general adaptation to water stress Ashraf and Foolad[9].

Woody Plant medium (WPM) supplemented with 7.2% sucrose, 6 mg/l NAA and 9 mg/l PBZ(PP 333) gave the best results for all parameters. A maximum number of shoot at 2 shoots/cultured shoot was obtained after 6 weeks of culture. Morphological characters; shoot length (cm) and diameter (cm), leaf number (5.7 leaves/shoot) and leaf width (1.2 cm) were maximum Khairun and Somporn[10].

Paclorbutrazol sprays with 125 and 250 ppm showed strong inhibition of annual total shoot growth of I.D.Red Delicious apple trees. There was a little effect on quality parameters of fruit at harvest time, Miliou and Sfakiotakis[11].

Application of CCC retarded shoot elongation, reducing shoot growth and enhanced lateral development and it was very effective in controlling grapevine growth and improving percentage of fruiting buds, vine nutritional status, percentage of berry set, yield, number of cluster and cluster weight Elman et al.[12]. On the other hand, spraying fig treatments survived at high water stress with cycocel (CCC) or PP333 at 500ppm, resulted in increasing the resistance of plants to water stress. This resistance may be due to increasing the hard leaf character, total carbohydrate and minerals content, Zainab Behairy et al[13]. The role of chlorocholine chloride in thickening of culms that enhances plant stability improvement in water stress is expected. Shoot and root dry weight decreased at salinity stress as compared to control, however PP333, BA and CCC treatment caused a substantial increase in shoots and root dry weight over that of salt alone Guramanti et al[14]. The photosynthetic activity of each leaf from both shoots was increased by treatment with CCC, whereas respiratory activity was not affected with CCC. In the primary shoots, CCC treatment increased the contents of chlorophyll a and b in the leaves, but in the lateral shoots only chlorophyll b contents were increased. Dry weights of the leaves from the lateral shoots increased with CCC, but those of leaves located in the vicinity of nodes bearing the fruit clusters varied slightly or were almost the same as the dry weight of non-treated leaves. Leaf thickness was increased by CCC and paralleled the variation in dry weight. The leaf area was decreased by CCC, Takafuli et al[15].

MATERIALS AND METHODS

The investigation was conducted during two successive seasons (2008 and 2009) on grapevine (Vitis vinifera L.) named as Barrani, grown under the environmental conditions of Barrani - Matrouh Governorate Egypt. 99 vines were selected of untrained orchard and planted at 5x5m between vines and rows. All growers left their plants grow running on the soil surface, and depended on rainfall as the main source for irrigation. Similar size and vigor vines were chosen and the experiment treatments were arranged in a randomized complete block design arrangement with three replicates and two vines per each replicate. The treatments were as follows:

Control (without pruning or foliar spraying).
Pruning at 6 cans x 8 buds canes (bud load 48).
Pruning at 12 cans x 4 buds canes (bud load 48).
Foliar spraying with vapor-guard at 4%.
Foliar spraying with vapor-guard at 6%.
Foliar spraying with paraffin wax at 4%.
Foliar spraying with paraffin wax at 6%.
Foliar spraying with paclopatrazol at 500 ppm.
Foliar spraying with paclopatrazol at 1000 ppm.
Foliar spraying with cycocel at 500 ppm.
Foliar spraying with cycocel at 1000ppm.

The experimented vines were pruned to either:

Six cans each contained eight buds canes (48 buds / vine) or twelve cans each contained four buds canes (48 buds / vine).

All vines were pruning in the last week of December in both studied seasons, both antitranspirants (vapor-guard at 4, 6% and paraffin wax at 8, 10%) were sprayed as a foliar application twice at the first April and after one week from the first spraying in both seasons by using a hand pressure sprayer. while (PP333 at 500,1000ppm and CCC at 500,1000ppm) were sprayed twice on the first May and after one week from the first spray.

The following parameters were determined to evaluate the tested treatments:

Vegetative Growth Parameters:
-Leaf Area (cm2): Leaf area was determined according to Sourial et al.[16] as follows:
Leaf area (cm2) = (diameter) 2 x 3.14

-Leaf Total Chlorophyll Contents: Total chlorophyll content (in fresh leaves) was measured in the field using Minolta chlorophyll meter SPAD – 502.

-Leaf Fresh and Dry Weight: At the end of each season, leaf samples were taken and carefully washed with tap water then distilled water and then determined the leaf fresh weight and dried at 70 O C .till a constant

weight then leaf dry weight was determined.

-Shoots Length (cm²): At the end of the growing season, the lengths of ten shoots distributed around the vine head were measured and the average was recorded.

-Yield/vine (kg): At harvesting time the yield expressed in weight (kg) and cluster number /vine were recorded, while the average weight of cluster was estimated.

-Berries Physical and Chemical Characteristics: A sample of clusters (3cluster from each replicate) were randomly taken and a sample of 100berries were randomly chosen from each replicate to determine berries quality in terms of berry weight (g), berry length (cm2), berry diameter (cm) and juice volume per 100berries were determined and recorded. Also, total soluble solids (TSS)in juice using hand refractometer, total acidity in juice as percentage of tartaric acid and total soluble solids/acid ratio calculated according to A.O.A.C.[17].

-Leaf Proline Content: Extraction and determination of praline and expressed as mg/100g dry weight was performed according to the method of Bates et al.[31]. Leaf sampling(1g)were extracted with 3% sulphosalicylic acid. Extracts (2ml) were held for 1h in boiling water by adding (2ml) minhydrin and (2ml) glacial acetic acid, after which cold toluene (4ml) was added. Proline content was measured by a spectrophotometer at 520nm.

All obtained data in both seasons were subjected to analysis the variance according to Snedecor and Cochran[19]. The differences among means of application date and tested treatments were determined by Duncan's multiple range test Duncan,[20]. The differences among interactions were differentiated using L.S.D method at 5% level.

RESULTS AND DISCUSSION

Vegetative Growth: Drought treatments had a significant inhibitory effect on the growth. Table (1) showed the effect of some mitigating treatments drought effect on Barrani grapevines. Leaf area, total chlorophyll content, shoots length, leaf fresh and dry weights were significantly reduced by treatments. In this respect, spraying with vapor-guard at 4and 6%, paraffin wax at 8 and 10%, PP₃₃₃ at 500,1000ppm and CCC at 500,1000ppm reduced vegetative growth parameters (leaf area, total chlorophyll, shoot length, and fresh and dry weight) in both studied seasons compared with the control.

On the other hand, stressed plants had a significantly lower leaf area than that of the control plant and the lowest values were obtained with spraying treatments especially CCC at 500 or 1000ppm and other treatments compared with control and pruning treatment in the two studied seasons. Total chlorophyll content was slightly decreased by all treatments in both studied seasons compared with the untreated treatment (control). Shoot length was affected by treatments and reduced, this results was clearly noticed in the second season, while in the first season there were no differences between treatment compared with the control. Meanwhile, leaf fresh and dry weight were decreased by spraying treatments with vapor-guard at 4and6%, paraffin wax at 8,10%, PP₃₃₃ and CCC at 500,1000ppm, but not affected by pruning treatments in two studied seasons.

Generally, vines sprayed by CCC at two rate 500 and 1000ppm recorded the lowest percentages followed by vines sprayed by PP₃₃₃ at two rats 500 and 1000ppm, in vegetative growth parameters (leaf area, total chlorophyll, shoot length, fresh and dry weight) in both studied seasons compared with control. In this respect, pruning treatments at the two methods (long canes pruning 12 canes x 4 buds and short cans pruning 6canes x 8 buds) gave the highest values of vegetative growth parameters after control compared with other treatments.

The period of pruning and doses of nitrogen fertilizer before the natural sprout can modify the vegetative growth and the expression. On the other hand, low relative humidity and dry soil also induced delayed bud break and stimulated excessive shoot growth after harvest to such an extent that cane mass was significantly higher compared to irrigation at 60% PAW depletion. Neither water deficits nor significant shoot growth during the post-harvest period had any effect on cane starch content at pruning Carlos et al.[21] and Myburgh.[22]. Besides, environmental stress, such as water deficit or limited nitrogen availability, reduces water deficit stress has one negative effect (reduction of photosynthesis), and positive effects on shoot growth cessation This can be explained not only by a reduced competition for sugars between shoot growth and fruit ripening, but also by reduced berry size Van Leeuwen[23]. Meanwhile, studying the effects of irrigation management strategies during ripening on the quality of Spanish field-grown grapevine (Vitis vinifera L.). Reveled that ascertain the effect of irrigation on berry development and ripening, and hence on grape vegetative growth Maria et al.[24]. The influence of PP₃₃₃ was intermediate between that of CCC and SADH. The concentration of the chemicals did not make any clear difference. CEPA increased the inhibition of growth.
ppm showed strong inhibition of annual total shoot growth of I.D.Red Delicious apple trees. There was a little effect on quality parameters of fruit at harvest time, Miliou and Sfakiotakis[11].

When the vine shoots were sprayed with cycocel at 0, 500, 1000, 1500, 2000 and 2500mg.L-1, 60 days after pruning. The variables evaluated were: percentage of fertile buds; distribution of fertile buds per shoot sector; percentage of bud necrosis; weight, length and diameter of internodes. Applications of cycocel linearly increased the percentage of bud fertility and the proportion of fertile buds between first and fifth basal buds. Furthermore, this growth regulator reduced the incidence of bud necrosis and the weight of internodes, presenting quadratic effect for these variables Renato et al.[25].

Similar results were obtained by Elman et al.[12], Takafumi et al.[15], Takafumi et al.[26], Kamande et al.[27], Christo and Iordan[28], Nagarajah[29], Yoshiyuki, [30], Pascual[31] and Huseyn et al.[25].

Vine Yield: Data in Table (2) indicated that, yield per vine expressed in cluster number per vine and cluster weight was gradually increased by all treatments as compared with the control. Pruning, vapor-guard antitranspirants as foliar application at 4.6%, paraffin wax as foliar application at 8.10%, PP333 spraying at 500,1000ppm and CCC spraying as foliar application at 500,1000ppm recorded significant increase in cluster number / vine and cluster weight in both studied seasons.

Also, pruning methods (long canes pruning 12 canes x 4 buds and short canes pruning 6 canes x 8 buds) was obtained gave the lowest values of cluster number /vine and cluster weight as compared with other treatments but higher compared with the control in both studied seasons, while the highest values of cluster number /vine and cluster weight were obtained by CCC treatments at 500 and 1000ppm in both studied seasons and followed descending order by PP333 at 500 and 1000ppm.

In this respect, data in Table (2) recorded also that, treatment of CCC at 1000ppm gave the best values of cluster number and cluster weight in both studied seasons as compared with the control and other treatments.

Concerning, the ascending development in yield per vine (kg) was the maximum as vines received the spraying by CCC treatments at 500 and 1000ppm followed descending by PP333 spraying at 500 and 1000ppm in two studied seasons as compared with other treatments.

Effects of irrigation management strategies during ripening and the quality of Spanish field-grown grapevine (Vitis vinifera L.). revealed that yield and berry weight were significantly higher in all varieties and years under deficit irrigation.) Meanwhile, environmental stress, such as water deficit or limited nitrogen availability, reduces grape yield Maria et al.[24] and Van Leeuwen.[23]. The total yield of bearing of cv Clapp's Favourite was highest on trees sprayed with CCC or SADH, but there was a clear tendency to biennial bearing. The total yield of trees sprayed with
Table 2: Effect of pruning, antitranspirants and growth retardants on mitigating drought effects on fruit quality and leaf proline concentration in Barrani grapevines during 2008 and 2009 seasons.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Berry weight (g)</th>
<th>Berries no./cluster</th>
<th>Berry size (mm)</th>
<th>Leaf proline content (mg/100g D.W.)</th>
<th>Total sugars (%)</th>
<th>Acidity (%)</th>
<th>TSS(%)</th>
<th>Juice volume/100 berries (cm³)</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>167.4e 167.4e</td>
<td>18.95f 18.89d</td>
<td>0.47a 0.46a</td>
<td>16.58d 16.23 c</td>
<td>49.07 f 40.47 h</td>
<td>76.17d 62.53c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pruning at 6 canes x 8 buds</td>
<td>169.0e 173.6d</td>
<td>19.64e 19.33c</td>
<td>0.46a 0.46a</td>
<td>16.58d 16.23 g</td>
<td>49.19ef 41.72gh</td>
<td>66.00f 68.90d</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pruning at 12 canes x 4 buds</td>
<td>170.3e 175.0d</td>
<td>19.79e 20.14c</td>
<td>0.44a 0.46a</td>
<td>16.71d 16.10g</td>
<td>44.33de 43.78gh</td>
<td>71.40ef 72.13d</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin wax at 6%</td>
<td>178.1cd 183.0c</td>
<td>20.58c 21.27b</td>
<td>0.41a 0.42a</td>
<td>17.33cd 18.07 f</td>
<td>49.40 c 50.72de</td>
<td>82.59ed 79.53c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin wax at 8%</td>
<td>182.1bc 183.5c</td>
<td>21.07c 21.11b</td>
<td>0.42a 0.42a</td>
<td>18.13 c 18.63 c</td>
<td>49.01 c 52.67d</td>
<td>84.66bc 83.70c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin wax at 10%</td>
<td>174.3e 184.9bc</td>
<td>20.00d 20.17c</td>
<td>0.44a 0.42a</td>
<td>17.99 c 18.88 d</td>
<td>45.48 d 47.41ef</td>
<td>84.23bc 91.83b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin wax at 12%</td>
<td>168.5e 182.8c</td>
<td>19.89e 19.65c</td>
<td>0.43a 0.43a</td>
<td>17.80 c 18.16 f</td>
<td>46.18 g 45.11fg</td>
<td>90.66ub 90.77b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin wax at 15%</td>
<td>191.6a 191.0ab</td>
<td>22.15f 23.28a</td>
<td>0.41a 0.40a</td>
<td>19.34 b 20.14 c</td>
<td>54.05 b 57.76bc</td>
<td>91.48ob 95.63ab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin wax at 20%</td>
<td>193.9a 198.1a</td>
<td>22.89a 22.16b</td>
<td>0.39a 0.39a</td>
<td>20.03ab 20.09 c</td>
<td>58.20 a 56.35 c</td>
<td>93.83a 97.37ab</td>
<td></td>
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</tr>
<tr>
<td>Paraffin wax at 25%</td>
<td>187.4ab 197.4a</td>
<td>23.3a 23.3a</td>
<td>0.40a 0.38a</td>
<td>20.26a 20.53 a</td>
<td>57.81ab 60.42ab</td>
<td>96.23a 98.90a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin wax at 30%</td>
<td>189.1bc 197.0a</td>
<td>22.49a 23.97a</td>
<td>0.40a 0.39a</td>
<td>19.64b 20.35 b</td>
<td>55.80ab 61.49 a</td>
<td>95.73a 96.63ab</td>
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</tbody>
</table>

Means within each column having different letter (s) are significantly different using Duncan’s multiple range test at the 5% level.

In the absence of irrigation, own-rooted vines yielded as much fruit as vines grafted on Ramsey, the highest-yielding unirrigated rootstock–scion combination. The yield of all vines increased significantly when a small volume of irrigation water (40–160 mm/annum) was applied; however, only scions grafted to Ramsey and Freedom rootstock yielded more fruit than own rooted. On the other hand, irrigation increased vine evapotranspiration and yield was 31% higher in the irrigated vines compared with unirrigated. This increase in yield was primarily due to larger berry size and was correlated with vine evapotranspiration estimated by soil water balance. Irrigation did not alter the balance between the vine demand and the supply as indicated by the similar level of yield to pruning weight and leaf area to yield ratios observed in both irrigated and no irrigated vines McFarlane et al.[33] Diego and Juan[34].

These results are in agreement with those obtained by Kamande et al.[27], Christo et al.[28] and Nagarajah[29] on grapevines, Pascual et al.[31] on almond tree, Saleh and Soad M. El-Ashry[6] on Washington navel and Succary orange trees and Abd El-Kader et al.[35] on Williams’s banana plants.

Fruit Properties:
A-fruit Physical Properties: Fruit physical properties shown in Table (2, 3) revealed that, number of berry per cluster, berry weight (g), 100 berries weight (g) and fruit juice volume were progressively improved by all spraying treatments by vapor-guard antitranspirants at 4, 6%, paraffin wax as foliar application at 8, 10%, PP333 spraying at 500, 1000ppm and CCC spraying as foliar application at 500, 1000ppm as compared with pruning treatments and compared with the control in both studied seasons.
Results further indicated that, spraying Barrani grapevines with CCC at 500, 1000ppm showed significant response in improving berry properties (no. of berries /cluster, berry weight (g) and 100berries weight) and gave the highest values in this respect followed descending by PP333 treatments at 500, 1000ppm in both studied seasons. Pruning methods was obtained gave the lowest values of number of berry per cluster, berry weight (g), 100berries weight (g) and fruit juice volume.

B-Fruit Chemical Properties: It clear from Table (3) that the total soluble solids (TSS) % was significantly affected and increased by all treatments, but spraying treatments gave the best values espically spraying with CCC at 500 and 1000ppm which gave the highest values in TSS % in both studied seasons as compared with other treatments followed descending by PP333 treatments. While acidity percentage were not affected by treatments and no trend was detected. Total sugars% and TSS: Acid ratios were significantly increased by spraying treatments all treatments gave positive effect of increasing total sugars percentage. In this respect, PP333 and CCC treatments gave the highest values of total sugars and TSS: acid ratio when sprayed at 500 or 1000ppm. On the other hand, CCC spraying at 500ppm gave the highest values of total sugars as compared with other treatments in the two studied seasons.

In both studied seasons, data in Table (3) showed the increment in proline content in leaves by spraying treatments (vapor-guard antitranspirants at 4, 6%, paraffin wax as foliar application at 8, 10%, PP333 and CCC at 500, 1000ppm compared with control. In this respect, PP333 and CCC treatments at the two application rates gave the highest values of proline contents in leaves, while pruning treatments gave the lowest values on proline content of leaves.

Paclobutrazol PP333 sprays with 125 and 250 ppm showed strong inhibition of annual total shoot growth of I.D.Red Delicious apple trees. There was a little effect on quality parameters of fruit at harvest time, Miliou and Sfakiotakis.[10]

Deficit irrigation induced higher titratable acidity, higher malic acid and potassium contents and a lower pH, but had no significant effects on berry sugar accumulation or tartaric acid content. Deficit irrigation thus appears to be a promising technique for the production of quality young wines in semi-arid areas. Also, environmental stress, such as water deficit or limited nitrogen availability generally promotes grape quality potential for red table wine production. Water deficit stress induced higher positive effects of reduction of berry size and stimulation of phenolic compound synthesis. Mild water deficit stress increases berry quality potential, despite reduced photosynthesis Maria et al.[23] and Van Leeuwen[21]. Similar results were obtained by Nagarajah[20] and Hipolito et al.[30] on grapevine. Spreer et al.[37] on mango trees, Saleh and Soad M. El-Ashry,[9] on Washington navel and Succary orange trees.

REFERENCES


