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SUMMER PRUNING AND FOLIAR APPLICATION WITH Fe, Zn and Mn FOR THOMPSON SEEDLESS GRAPEVINES

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ABSTRACT

During two successive years 2001 and 2002 Thompson Seedless grapevines were subjected to summer pruning practices (head suckering + pinching the main shoots and topping the laterals) and mineral nutrition of chelated Fe, Zn and Mn together at 0.1% each, applied after head suckering; 10 days before anthesis and after fruit set (at 3mm berry diameter). The vines received one, two or three sprays of Fe + Zn + Mn according to the time of spraying. The number of treatments was ten. Shoot growth rate was in April > in May > in June > in July. All treatments increased shoot growth rate compared with the control. Carbohydrate content of the cane was higher in February then decreased in March and April. The content remained almost unchanged from April to August. Carbohydrate content of the shoot increased progressively. Spraying Fe, Zn and Mn + summer pruning increased carbohydrate content in canes; shoots and new canes, especially when applied 10 days before anthesis. Bunch weight, yield, TSS, Fe. Zn and Mn were increased, whereas acidity was decreased. The number of clusters/vine was not affected in the year of application. However, it was significantly increased in the following season. The results indicated that one spray of Fe + Zn + Mn at 0.1% each 10 days before anthesis + summer pruning seemed to be sufficient and reduced mineral nutrition costs by about 50% at least.

INTRODUCTION

Summer pruning is an important practice carried out in vineyards. It gains its importance from the fact that it is a complementary process for the previous winter pruning and a preparatory practice for the subsequent winter pruning. The effect of summer pruning on the growth and yield of grapevines was reported by many researchers (Vargas, 1984; Mann and Kushual, 1985; Reynolds, 1989; Wolf *et al.,* 1990; Elgendy, 1995; and Ibrahim *et al.,* 2001).

Foliar application of Fe, Zn and Mn is a regular process carried out in vineyards especially in the desert. Fe is necessary for chlorophyll synthesis (Van Noort and Wallace, 1965). Moreover, iron-metallo proteins participate in *redox reactions (Clarkson and Hanson, 1980). Zinc is necessary in the biosynthesis of chlorophyll precursor and in photosynthesis (Yagodin, 1984) and in the synthesis of IAA (Faust, 1989). Mn is essential for photosynthesis (Fogg, 1972). In addition, the phytolysis of water and evolution of oxygen in Hill reaction is a Mn dependant process (Hall *et al.,* 1972). The addition of Fe, Zn and Mn increased leaf chlorophyll by 80% over control (Basiouny and Biggs, 1976).

Abdelfattah (1993) sprayed Roomy Ahmar grapevines with Fe, Zn and Mn twice a year, i.e. 10 days before full bloom and again when the berry reached one third of its final size.

***Reduction oxidation**

Elshahat *et al.,* (1996) sprayed Thompson seedless grapevines with Fe, Zn and Mn or B two weeks before blooming and one week after fruit set. Mansour *et al.,* (2000) treated Thompson Seedless grapevines with Fe, Zn and Mn three times, at growth start, just after berry set and 30 days later. Elmorsy (2001) sprayed flame Seedless grapevines with Fe, Zn and Mg five times, at growth start and thereafter at two weeks intervals. The elements mentioned in the previous studies were used individually or in combination and resulted in improving fruit quality and increasing yield and mineral content in the leaf petiole. However, none of those studies determined the sufficient number of sprays or the suitable time of the application for each spray in relation to summer pruning.

The information regarding the relationship between S.Pr. and number and time of M.nut. spray are rare. Hence, the idea of this study is to determine the sufficient number of sprays and the suitable time of spraying Fe + Zn + Mn and the role of summer pruning in this connection.

MATERIALS AND METHODS

One hundred and twenty ten-year-old Thompson Seedless grapevines, grown in a sandy soil in a private farm located in El Khatatba region, were chosen for this study in 2001 and 2002. The vines were planted at 1.5 × 3 meter apart and supported by Y-shaped system. At winter pruning in the last week of December bud load/vine was adjusted to 72 (6 canes × 12 buds/cane). Dormex (a dormancy breaking agent) was sprayed at 3% followed by 2% summer mineral oil (one week after Dormex spray, Omar and Girgis, 2004). Summer pruning (S.Pr) was carried out as follows: Head suckering, pinching the main shoots and topping the laterals. Head suckering (H.Suck) was applied when the average length of the shoot was 20 cm., by removing the unwanted shoots grown inside the head of the vine, The main shoots were pinched by removing 1-2cm one week before anthesis, whereas laterals were topped to 4-5 leaves when the average length of the laterals was 25-30cm. The mineral nutrition (M.nut.) was carried out by spraying with the chelated Fe, Zn and Mn at 0.1% each after H.Suck; 10 days before anthesis and after fruit set (berry diameter 3mm).

Properties of the soil : Sand 88%, silt 6%, clay 5%; texture sandy, pH 7.9, E.C. 1.3 mmhos/cm, $CaCO_3$ 1.85%; Fe 1.5 ppm, Zn 2.1 ppm and Mn 9.0 ppm.

The experiment included ten treatments, as follows :

1- Control
2- Summer pruning only (S.Pr).
3- M. nut. Only (after H.Suck. + 10 days before anthesis + after fruit set)
4- S.Pr + M.nut. after H.Suck (A)
5- S.Pr. + M.nut. (10 days before anthesis) (B)
6- S.Pr. + M.nut. after fruit set (berry diameter 3mm) (C)
7- A + B
8- A + C
9- B + C
10- A + B + C

The treatments were arranged in a randomized complete block design. Each treatment contained three replicates with 4 grapevines per replicate. The vines of each treatment were divided into two equal groups. The first group was used to study weekly growth rate (WGR) of the shoot (April-July); monthly changes in total carbohydrates in canes (February-August) and in shoots (April-August). Carbohydrates were determined according to Dubois *et al.*, (1956). The second group was kept to investigate : number and weight of clusters; weight of 100 berries; yield/vine; TSS; acidity (according to A.O.A.C, 1985). Harvesting was carried out when TSS of the control reached 16.0, TSS/acid ratio was also calculated. A week after the last M.nut. spray, petioles of the leaves opposite to the clusters were collected to determine Fe, Zn and Mn (ppm) following the method described by Wilde *et al.*, (1985). Also, carbohydrates in new canes were determined in December.

Duncan's multiple range test at 0.05 level was followed to compare the average of treatments according to Snedecor and Cochran (1980).

Abbreviations : Tr. = Treatment, H.Suck. = Head suckering,
Pin. = Pinching, S.Pr. = Summer pruning, M.nut. = Mineral nutrition,
SGR= Shoot growth rate and WGR =Weekly growth rate.

RESULTS AND DISCUSSION

Shoot growth rate (SGR) :

The effect of summer pruning (S.Pr.) and mineral nutrition (M.nut.) on shoot growth rate (SGR) is presented in Figs 1 and 2. It is apparent that three stages can be distinguished: stage A: from bud burst to anthesis. Measurements of WGR started in 5th of April for both seasons. All treatments were found to increase SGR compared with control. This stage was distinguished by the highest values of SGR.

Stage B: The SGR decreased rapidly at anthesis, April 14th and 17th in the 1st and 2nd seasons, respectively. It is worthy to observe that all treatments achieved higher SGR values than control. Stage C: began after fruit set and was characterized by the lowest SGR values compared with the other two stages. During May, the SGR values of treatments receiving M.nut. at berry size 3mm (Trs. 6, 8, 9 and 10) were relatively higher.

The positive effect of H.Suck. on SGR is due to the redistribution of nutrients among a lower number of shoots. The application of M.nut. positively affected the SGR via increasing of chlorophyll which sustained higher rates of photosynthesis (Basiouny and Biggs, 1976). Photosynthesis by its turn, increased carbohydrates and hence SGR. The sharp decrease of SGR in stage B was emphasized by Weaver (1976), who mentioned that SGR begins to slow down by bloom time, while the decrease of SGR in the stage C is due to the cluster consumption of carbohydrates (Kliewer, 1981). It is worth-mentioning that S.Pr. maximized the effect of mineral nutrition. The results are in agreement with those of Elgendy (1995) concerning the effect of S.Pr. on SGR.

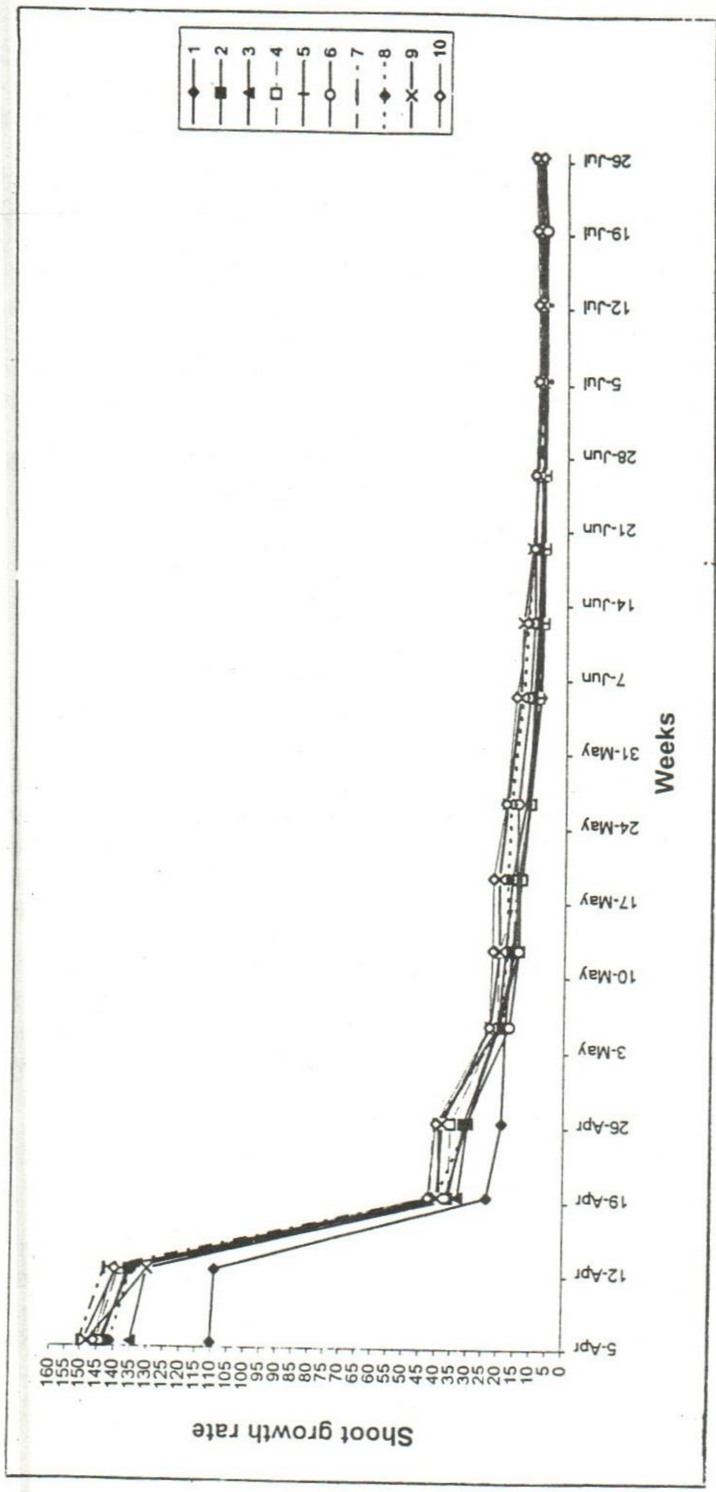

Fig. (1) : Effect of summer pruning and foliar application with Fe, Zn znd Mn on shoot growth rate of Thompson Seedless grapevines 2001

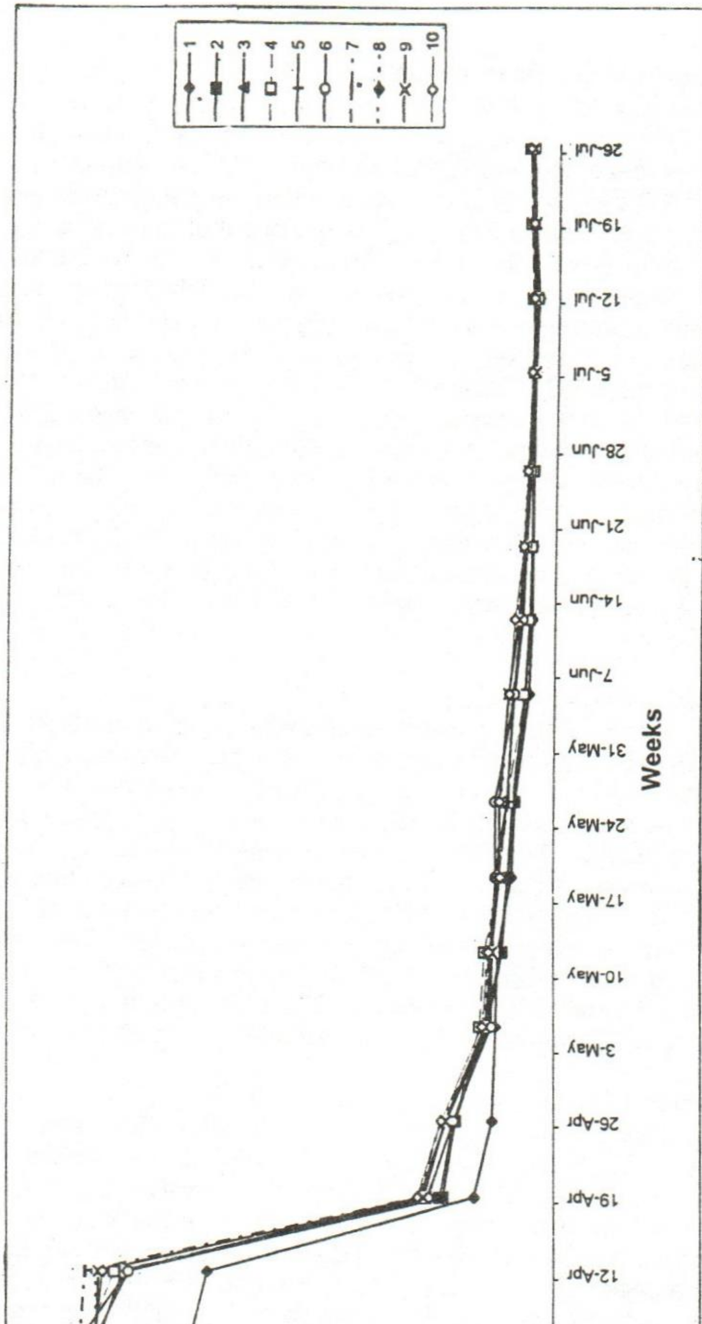

Fig. (2) : Effect of summer pruning and foliar application with Fe, Zn znd Mn on shoot growth rate of Thompson Seedless grapevines 2002

Total carbohydrates in canes and shoots :

Total carbohydrates in canes changed during the period from February to August. In February, carbohydrates stored in the canes were higher followed by a decrease through March till April. There was almost no changes in carbohydrate content in the canes during the period from April to July, then increased in August (Fig. 3). It is obvious that the application of M.nut. 10 days before anthesis + S.Pr. (treatments No. 5, 7, 9 and 10) achieved higher values than the other treatments. Carbohydrate content in the shoots showed a progressive increase through the season (Fig. 4). This led to an increase in number of clusters and consequently the yield/vine in the following season 2002 (Table, 1). Summer pruning and/or M.nut. significantly increased carbohydrate content in the new canes sampled in December. The highest values were recorded for treatments including S.Pr. + M.nut. 10 days before anthesis. Summer pruning increases solar radiation received by the leaves in the interior canopy, which by its turn increases photosynthesis and consequently carbohydrates (Kliewer, 1981). The effect of Fe, Zn and Mn on carbohydrates could be explained by the studies of Basiouny and Biggs (1976) and Kliewer (1981) as mentioned in the discussion of SGR.

TSS, acidity and TSS/acid ratio :

TSS, acidity and TSS/acid were significantly affected by S.Pr. and M.nut. (Table, 1). TSS was positively affected. The best results were found in treatments including S.Pr. + M.nut. 10 days before anthesis (Tr. 5, 7, 9 and 10). A similar trend was recorded for TSS/acid ratio. On the contrary, acidity was negatively affected. The lowest acidity values were found in M.nut. applied 10 days before anthesis. These results clearly showed that S.Pr. alone or + M.nut. can improve berry quality through increasing TSS, TSS/acid and lowering acidity. The results are in accordance with those of Selim *et al.*, (1977); Wang (1989) and Elgendy (1995) who found that S.Pr. increased TSS and decreased acidity in the berry juice. The same results were true for M.nut. as reported by Elfishawi (1992) and Mansour *et al.*, (2000).

Number of clusters/vine :

Number of clusters/vine was insignificantly affected by S.Pr. and M.nut. in the first season (2001), since the primordia of grape flower clusters have already been formed in the preceding year. However, number of clusters/vine was significantly increased in the second season (Table, 1).

The best results were recorded for treatments including spraying M.nut. 10 days before anthesis (Tr. 5, 7, 9 and 10). The role of S.Pr. in increasing the number of clusters/vine can be explained by its promotion on the development of embryonic shoot growth and hence the number of clusters inside the winter bud (Winkler *et al.*, 1974). The M.nut. had a positive influence on the differentiation of flower buds (Stamper and Hudina, 2000). It was found that percentage of starch in the annual wood is closely associated with fruit bud formation (Winkler, 1974). The results are in agreement with those of Mann and Kushal (1985); Elgendy (1995); Elmorsy (2001) and Marwad *et al.*, (2001).

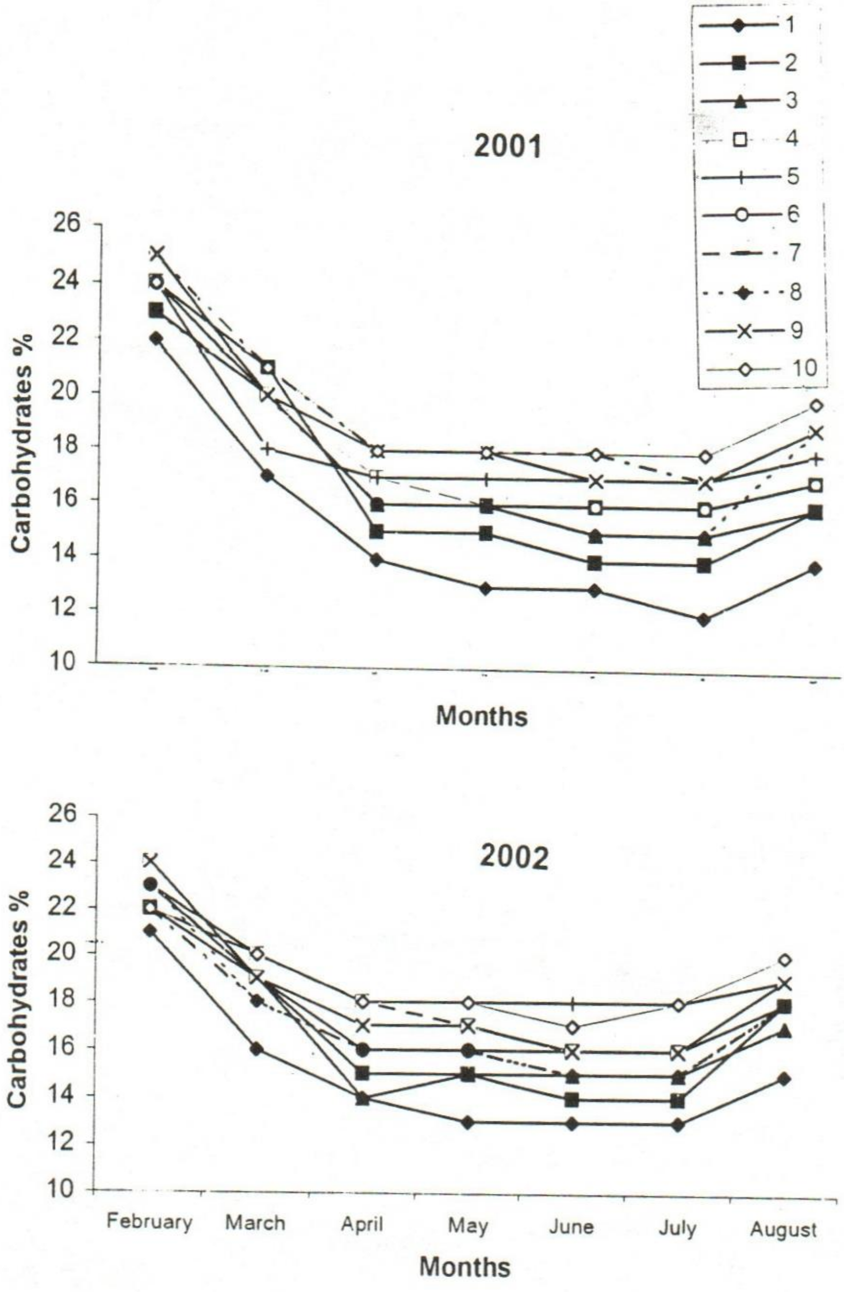

Fig. (3) : Effect of summer pruning and foliar application with Fe, Zn and Mn on total carbohydrates % in canes of Thompson Seedless grapevines

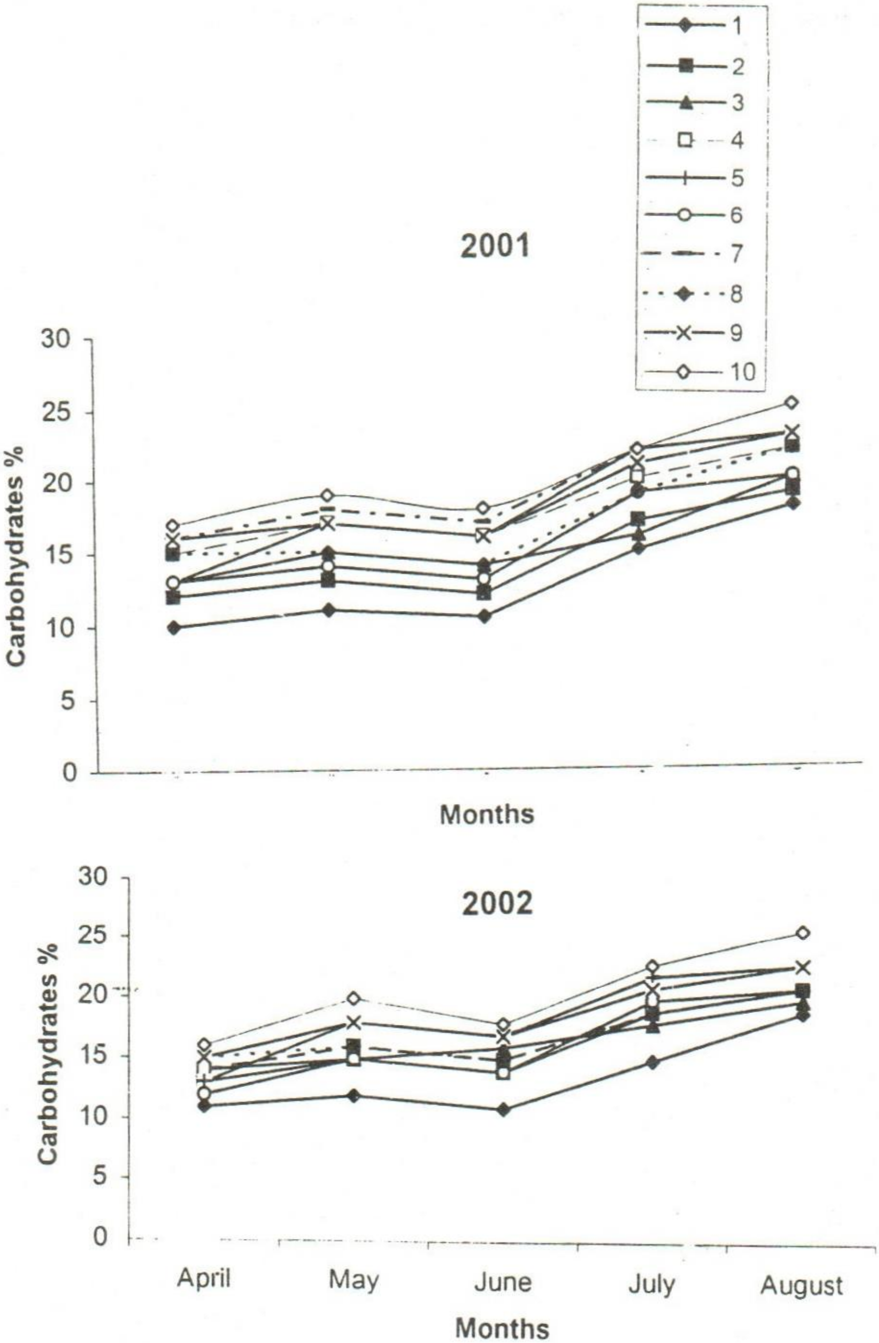

Fig. (4) : Effect of summer pruning and foliar application with Fe, Zn and Mn on total carbohydrates % in shoots of Thompson Seedless grapevines

Table (1) : Effect of summer pruning and foliar application with Fe, Zn and Mn on carbohydrates, yield and bunch characteristics of Thomspon Seedless grapeviness

Treatment	Carbohydrates in the new canes g/100g D.W		TSS%		Acidity		TSS/acid ratio		Number of clusters/vine		Cluster weight (g)		Weight of 100 berries (g)		Yield/vine (Kg)		Yield increase % than control	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
1	17.0^{d}	17.8^{d}	16.0^{c}	16.0^{c}	0.90^{a}	0.92^{a}	17.8^{c}	17.4^{c}	12.0^{a}	12.0^{c}	403^{c}	410^{b}	182^{b}	190^{b}	4.8^{c}	4.9^{c}	---	---
2	19.5^{c}	18.9^{c}	17.2^{b}	17.3^{b}	0.80^{a}	0.81^{a}	21.5^{b}	21.4^{b}	12.0^{a}	12.0^{c}	430^{b}	450^{b}	190^{b}	200^{b}	5.2^{c}	5.4^{bc}	8	1
3	18.6^{c}	19.0^{c}	16.1^{c}	16.2^{c}	0.82^{a}	0.83^{a}	19.6^{bc}	19.6^{bc}	12.0^{a}	13.0^{c}	408^{c}	410^{c}	195^{b}	200^{b}	4.9^{c}	5.3^{bc}	2	0
4	22.4^{b}	23.4^{b}	17.5^{b}	17.3^{b}	0.80^{a}	0.80^{a}	21.9^{b}	21.6^{b}	13.0^{a}	15.0^{b}	485^{ab}	440^{b}	210^{a}	205^{b}	6.3^{a}	6.6^{b}	37	35
5	27.0^{a}	26.2^{a}	18.4^{a}	18.5^{a}	0.72^{b}	0.75^{b}	25.6^{a}	24.7^{a}	14.0^{a}	17.0^{a}	510$_{a}$	520^{a}	215^{a}	225^{a}	6.1^{a}	8.8^{a}	27	79
6	24.4^{b}	23.5^{b}	17.6^{b}	17.5^{ab}	0.79^{a}	0.78^{a}	22.3^{b}	22.4^{b}	12.0^{a}	15.0^{b}	500^{a}	500^{a}	220^{a}	215^{a}	6.0^{a}	7.5^{a}	25	63
7	27.8^{a}	27.5^{a}	18.5^{a}	18.4^{a}	0.70^{b}	0.71^{b}	26.4^{a}	25.9^{a}	12.0^{a}	16.0^{ab}	530^{a}	500^{a}	217^{a}	220^{a}	6.3^{a}	8.0^{a}	37	63
8	23.0^{b}	23.8^{b}	17.8^{ab}	17.6^{ab}	0.77^{ab}	0.76^{ab}	23.1^{ab}	23.2^{ab}	14.0^{a}	16.0^{a}	500^{a}	500^{a}	215^{a}	215^{a}	7.0^{a}	8.0^{a}	45	63
9	26.3^{a}	27.0^{a}	18.3^{a}	18.5^{a}	0.70^{b}	0.72^{b}	26.1^{a}	25.6^{a}	14^{a}	16.0^{a}	510^{a}	500^{a}	215^{a}	217^{a}	7.1^{a}	8.0^{a}	48	63
10	26.6^{a}	27.8^{a}	18.2^{a}	18.3^{a}	0.72^{b}	0.72^{b}	25.3^{a}	25.4^{a}	13^{a}	16.0^{ab}	510^{a}	510^{a}	220^{a}	217^{a}	6.6^{a}	8.2^{a}	38	67

Cluster weight and yield/vine :

It is obvious from Table (1) that S.Pr. alone or accompanied by M.nut. (Fe + Zn + Mn), significantly increased cluster weight and yield per vine. The best results were recorded as a result of S.Pr. and M.nut.. S.Pr. + M.nut. significantly increased berry weight compared with the other treatments. Yield per vine showed a trend similar to that of cluster weight. The best results were obtained from treatments including the application of M.nut. in 2001. The highest yield increase in 2002 was recorded for Tr.5. This effect could be ascribed to the increase in cluster weight in the first season and to the increase of number of clusters/vine beside the increase in cluster weight in the second season. It seems that M.nut. alone is not sufficient to increase yield and its components because of the density of foliage of the vine which prevents the penetration of the light and air circulation inside the canopy. This provides an evidence for the importance of S.Pr. In this respect, the same observations were reported by Elgendy (1995) for S.Pr.; Elfishawi (1992); Abdelfattah (1993); Elmorsy (2001); Ibrahim *et al.,* (2001) and Marwad *et al.,* (2001) for M.nut..

Leaf mineral content :

Leaf content of mineral elements (Fe, Zn, Mn) was significantly affected by S.Pr. and mineral nutrition (Table, 2). S.Pr. increased Fe, Zn and Mn contents in petioles of the leaves in the two seasons (Tr.2). The highest contents were recorded for the interaction treatments, specially those including spraying M.nut. after fruit set (Tr. 6, 7, 8 and 10). This was valid for the samples taken two weeks after spraying M.nut. after fruit set. This effect could be ascribed to the redistribution of the nutrients after S.Pr. and the absorption of the nutrients through the leaves, after M.nut. application. The results are in line with those obtained by Bacha *et al.,* (1995); Fargues and Silva (1998) and Elmorsy (2001).

Table (2) : Effect of summer pruning and foliar application with Fe, Zn and Mn on leaf mineral content of Thomspon Seedless grapevines

Treatment	Fe ppm		Zn ppm		Mn ppm	
	2001	2002	2001	2002	2001	2002
1	64^{c}	63^{c}	40^{c}	38^{c}	51^{d}	50^{d}
2	69^{c}	80^{c}	44^{c}	42^{c}	56^{d}	51^{d}
3	120^{a}	121^{a}	58^{a}	60^{a}	120^{a}	115^{a}
4	88^{c}	82^{c}	52^{b}	54^{b}	65^{c}	63^{c}
5	112^{b}	112^{b}	55^{b}	53^{b}	96^{b}	94^{b}
6	124^{a}	123^{a}	59^{a}	60^{a}	120^{a}	118^{a}
7	110^{b}	107^{b}	50^{b}	50^{a}	110^{ab}	111^{ab}
8	128^{a}	129^{a}	60^{a}	62^{a}	117^{a}	113^{a}
9	135^{a}	135^{a}	61^{a}	61^{a}	123^{a}	120^{a}
10	130^{a}	135^{a}	61^{a}	64^{a}	125_{a}	122^{a}

Values with the same letter (s) are not significantly different at 0.05 level.

Hence, it can be concluded that summer pruning and one application of Fe + Zn + Mn at 0.1% for each element 10 days before anethsis seemed to be sufficient for Thompson Seedless grapevines. As previously mentioned in the introduction, many researchers sprayed M.nut. 2-5 times a year. As a consequence of this study, we can save at least 50% of the mineral nutrition costs, beside increasing the yield.

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التقليم الصيفي والرش الورقي بالحديد والزنك والمنجنيز لكروم العنب الطومسون اللابذري

أحمد حسين عمر

قسم بحوث العنب – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر

أجريت هذه الدراسة لمدة عامين متتاليين ٢٠٠١ ، ٢٠٠٢ علي أشجار عنب صنف الطومسون سيدلس حيث أجريت عملية التقليم الصيفي ، والرش بعناصر الحديد والزنك والمنجنيز المخلبية معاً بتركيز ٠,١% لكل عنصر بعد السرطنة التاجية ، ١٠ ايام قبل التزهير ثم بعد العقد (عند وصول قطر الحبة ٣مم) وقد رشت الكروم رشة ، رشتان أو ثلاث رشات حسب ميعاد الرش. وكان عدد المعاملات عشرة. وقد وجد أن معدل نمو الأفرخ في إبريل > مايو > يونيو> يوليو. وقد زادت معاملات التقليم الصيفي وكذلك معاملات التقليم الصيفي + الرش بالعناصر السابقة خصوصاً تلك التي رشت بعد السرطنة التاجية وقبل التزهير بعشرة أيام من معدل نمو الأفرخ. كان محتوي القصبات من الكربوهيدرات عالياً في فبراير ثم انخفض في مارس وابريل بينما لم يتغير خلال الفترة من إبريل إلي أغسطس. أما في الأفرخ فقد إزداد محتواها من الكربوهيدرات بإضطراد بتقدم الموسم وقد زادت المعاملات من هذا المحتوي بالمقارنة بالكنترول. أدت المعاملات السابقة إلي زيادة محتوي القصبات الجديدة من الكربوهيدرات في ديسمبر كما ازداد عدد العناقيد معنوياً في الموسم الثاني خصوصاً في المعاملات التي إشتملت علي رش العناصر قبل التزهير بعشرة أيام. وعموماً فقد زادت المعاملات من وزن العنقود والمحصول والمواد الصلبة الذائبة بعصير الحبات بينما أدت إلي خفض الحموضة. وقد استنتج أن التقليم الصيفي + الرش بالحديد والزنك والمنجنيز معاً بتركيز ٠,١% مرة واحدة قبل التزهير بعشرة أيام كان كافياً ، إضافة إلي خفض تكاليف رش العناصر الصغري بحوالي ٥٠%.