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PHYSIOLOGICAL STUDIES ON MATURITY INDICES AND STORABILITY OF EARLY SUPERIOR TABLE GRAPES.

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ABSTRACT

This investigation was carried out during two successive seasons (2002 and 2003) at the Hort. Res. Inst., Fruit handling department. Grapes were picked from a private farm at Cairo-Alex desert road. To determine maturity stage of Early Superior table grapes, samples were taken at weekly intervals begining from the second week of May. At maturity stage, samples for storage studies were picked in the early morning and directly transported to the laboratory to be examined and packed in carton boxes (2kg / box) lined with perforated polyethylene bags (luggage = 40 µ and *400 halls / m²*) *and stored at room temperature* (27 ± 5) , *5ºc and* 0ºc *and* 90 : 65 % RH. for 18 , 70 and 70 days, respectively. The Early Superior table grape is considered to be mature during the second week of July. (Treatment with dormancy agent is necessary). Also total soluble solid contents must be more than 15 %, total acidity contents less than 0.66 % and total soluble solid / total acidity ratio must be more than 25. As physical properties are more affected by the agricultural practice, it is not, always suitable for the determination of maturity stage for grapes. This study also confirmed that, Early Superior table grapes are very sensitive to the high temperature. The storage life of Early Superior table grape at room temperature did not exceed 12 days even with SO_2 fumigation treatment. Fumigation with SO_2 is necessary in order to keep quality of grapes during transport or storage especially when these periods were expected to exceed 21 days either at 5 ºC or 0 ºC temperatures. This study also indicated that grapes stored at 0 ºC had longer storability compared with grapes stored at 5 ºC especially in the first season. However, it is clear that, for short time storage or transport (less than 45 days), 5 ºC will be sufficient to keep grapes quality. While, for long time storage or transport, 0 ºC will be necessary to keep grape quality. Therefore, in all previous cases, fumigation with SO_2 is necessary

INTRODUCTION

Grape is one of the most important and favorable fruit crops in Egypt. The planted area in 2002 reached 152488 feddan, while the productive area reached 133897 feddan producing 1073815 ton according to Horticulture General Administration, M.O.A. (unpublished data). Egypt has a good opportunity for increasing the Egyptian share in the international grape trade One of the most promising new cultivars planted in Egypt is Early Superior. It is an early maturation cultivar with high productivity.

Mohamed (1994) reported that, bunch weight, berry weight and size, juice percentage, total soluble solid and total soluble solids / total acidity ratio increased continuously during the developmental stages of grapes while berry firmness and total acidity were decreased.

Grapes should be harvested as near as full maturity as possible, unlike many other fruits, grapes don't ripe after harvest and they should be picked only after they reach the optimum stage of acceptability appearance,

flavor, taste, and texture. Nelson, (1985) Mohamed, (1994), and the last author added that to determine fruit maturity, non physical and chemical constituents could be taken as an indicator for maturity in grapes, but most of them together may contribute to be a proper index.

Chikkasabbanna *et al* (1991) reported that TSS/Acid ratio could be used as an index of maturity the same results were concluded by Roberdo *et al* (1991) .On contrast Mansour *et al* (1981), mentioned that total soluble solid /acid ratio could not be used as an indication for maturity stage. Also they added that, the proper indices to define maturity stage in grapes were acidity contents and TSS. Similar results were obtain by Abarac, Lizana (1988) and Mohamed (1994)

It has been reported that, sulfur dioxide post harvest fumigation reduced decay incidence in the stored grapes, Asker *et al* (1988) .

Asker *et al* (1988) mentioned that post harvest fumigation with sulfur dioxide significantly decreased weight loss percentage in the stored grapes. Similar results were obtained by Morris *et al* (1992), Mohamed (1994), Cenci and Ferreira (1996), Castro *et al* (1998), Baneh *et al* (1999) and Mohamed (2002).

Morris *et al* (1992) in his study on Reliance and Saturn grape cultivars found that fumigating grapes with SO_2 generators (quick and dual-release SO_2 beds) significantly reduced shatter incidence during storage. Similar results were suggested by Sarig *et al* (1996), Yiqiang *et al* (1997), Baneh *et al* (1999) and Ling *et al* (1999).

Wasel (1985) mentioned that, post harvest SO_2 treatment significantly reduced total spoilage of grapes during storage. Similar trends were recorded by Sandhu *et al* (1992), Mohamed (1994) Al-Bachir (1996) and Mohamed (2002).

Mansour *et al* (1984) mentioned that berries treated with SO_2 were firmer than untreated ones. The same results were reported by Mohamed (1994), (2002).

Mansour *et al* (1984) found that stem drying and browning was reduced in Banati grapes when using quick release grapes guard (Q.R) during storage. The stems remained green and relatively fresh in the QR treated samples. Same results were found by Mustonen (1992), Morris *et al* (1992), Mohamed (1994), Soylemezoglu *et al* (1994), Kim (1994), Baneh *et al* (1999) and Mohamed (2002). On contrast Castro *et al* (1998) reported that the SO_2 generating treatment (Q.R.G.G.) had no effect on cluster appearance or stem browning.

Mohamed (1994) mentioned that fumigation with SO_2 had a significant effect on reducing TSS in fumigated grapes. Moreover fumigation with SO_2 had no obvious effect on total acidity. Similar results were reported by Mohamed (2002). On the other hand Asker *et al* (1988) reported that post harvest SO_2 treatments of grapes had no effect on TSS or total acidity contents during storage. The same results were recorded by Morris *et al* (1992), Cenci and Ferreira (1996). Yiqiang *et al* (1998) mentioned that SO_2 treatments significantly reduced total acidity contents of grapes during storage.

Some reports, mentioned that grapes stored at low temperature significantly had a long storage period and less decay, weight loss, shatter incidence compared with grapes stored at room temperature and fruit quality and storability of grapes increased as storage temperature decreased. Also the most factors causing losses (decay, shatter, and water loss) and deterioration were inhibited at low storage temperature compared with high temperature. Kim (1994), Mohamed (1994) and Munoz (2000).

This investigation was carried out to determine: A)- The maturity indices of Early Superior grapes. B)- The effect of SO_2 generators and storage temperatures (room temperature, 5°c and 0°c) on quality of Early Superior grape bunches during transport or storage.

MATERIALS AND METHODS

This investigation was carried out during two successive seasons (2002 & 2003) at Hort. Res. Inst. Giza, Egypt. Fruits were picked from a private farm at Cairo-Alex. desert road. The vines were 5 years old, planted on a spacing of 1.5 x 3 m in sandy soil, trained according to cane pruning and under drip irrigation system. During the first week of May, vines were selected to be the source of samples during maturity indices study. Samples were taken at weekly intervals from the second week of May. For preharvest study, all fruit quality parameters, such as average bunch weight, berry weight and size, berry color and firmness, juice percentage, total soluble solid contents and total acidity contents, were measured and tabulated. Three cluster samples were left under room temperature for 5 days at every harvest date. Fruit samples were tested at the third and fifth day for bunch weight loss percentage, bunch conditions, berry firmness, TSS, acidity and TSS/acid ratio to determine maturity stage. When fruit reached maturity stage, samples for storage study were taken .Fruits were picked in the early morning and directly transported to the laboratory where packed into 24 carton box (2Kg / box) lined with perforated polyethylene (40 µ, 400 walls / m^2, 1hall = 0.5cm) with SO_2 generators sheet (12 boxes) or without SO_2 generators (control, (12 boxes)). All treatments were stored at room temperature, 5°c, 0°c for 18, 70 and 70 days, respectively. Fruits stored at room temperature were tested two times per week while fruits stored at low temperature were tested at 14 days intervals for all fruit physical and chemical parameters. Decay, shatter, weight loss percentage were calculated according to the equal (weight of decayed or shattered berries or weight loss per box * 100 / the initial weight of box), total spoilage percentage was calculated as the sum of the last three parameters. Berry firmness were estimated in 15 berries by Ifra texture analyzer instrument using a penetrating cylinder of 1 mm of diameter to a constant distance 1 mm inside the skin of berry and by a constant speed 2 mm per sec. and the peak of resistance was recorded per gram. Bunch freshness was calculated as the average of stem color, stem dryness and berry appearance, and were estimated as follow:

Degree / The property	1	2	3	4
Stem color	Green	L. brown	Little green	Brown
Stem dryness	Plump	50% Dry	Dry	Very dry
Berry appearance	Excellent	Good	Acceptable	Poor

Total soluble solids were estimated by using the Abbè refractometer. (A.O.A.C., 1980). Total acidity contents were measured by titration against 0.1 N. Sodium hydroxide using phenolphthalein as indicator. (A.O.A.C., 1980). Data were subjected to analysis of variance as a three factorial experiment in random complete design as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Maturity indices

Physical characteristics:

Data presented in Table (1) show that, bunch weight, berry weight and size, juice percentage increased gradually and significantly till reached the maxim 14 days before harvest, while berry firmness was decreased with the extension of the maturity stage. These results are in line with those obtained by Mohamed (1994).

Chemical characteristics:

According to data presented in Table (1) and Figure (1) total soluble solids and TSS / total acidity ratio increased gradually and significantly till reached the maximum values at maturity stage while total acidity was decreased significantly to reach the minimum values at maturity stage.

These results are in accordance with those reported by Mohamed (1994).

Determination of maturity stage:

It is evident from the last illustrated tables and the changes of the physical and chemical properties during shelf life at different developmental growth stages (Table 2) during seasons (2002) and (2003) that, Early Superior could be considered as mature during the first week of June when TSS reach more than 15% and acidity reach less than 0.66 % and TSS acid ratio is more than 25:1.

Storage studies:

Decay, weight loss, shatter and total spoilage percentage:

Data presented in Tables (3, 4, 5 and 6) and Figures (2 and 3) clearly indicated that decay, weight loss, shatter and total spoilage percentage increased gradually and significantly with prolonging of storage period.

Data also show that, decay, weight loss, shatter incidence was decreased as storage temperature decreased .Also post harvest SO_2 treatments significantly reduced the incidence of all these parameters.

Table (1): physical and chemical properties development of Early Superior Berries during growing seasons (2002 and 2003).

	Berry properties							
	Bunch weight		Berry weight		Berry size		Berry firmness	
D.B.H	Fst. S.	Sec. S.	Fst. S.	Sec. S.	Fst. S.	Sec. S.	Fst. S.	Sec. S.
21	227	248	2.3	2.1	2.2	2.1	37.9	42.0
14	557	471	2.8	3.9	2.7	3.8	36.6	40.6
7	706	624	3.5	4.0	3.4	3.9	33.1	38.1
0	651	667	3.5	4.1	3.4	3.9	31.9	35.9
Means	548	503	3.03	3.55	2.93	3.43	34.88	39.15
LSD at 5%	228	179	0.7	1.11	0.73	1.36	N.S.	N.S.

Cont.

	Berry properties							
	Juice %		TSS %		T. Acidity %		TSS Acid ratio	
D.B.H	Fst. S.	Sec. S.	Fst. S.	Sec. S.	Fst. S.	Sec. S.	Fst. S.	Sec. S.
21	43.6	39.1	10.3	8.5	1.49	1.94	7.2	4.4
14	63.7	60.8	11.0	9.9	0.93	1.17	11.9	8.5
7	68.4	68.7	14.1	13.8	0.72	0.89	19.5	15.6
0	69.0	68.2	15.5	15.3	0.60	0.64	25.7	24.2
Means	61.16	59.23	12.73	11.86	0.94	1.16	16.08	13.18
LSD at 5%	10.86	10.29	1.65	1.45	0.30	0.13	2.61	3.31

Table (2): Changes in physical and chemical properties of Early Superior berries during maturation in 2002 and 2003.

Days before harvest		Weight loss %		Bunch Condition		Berry firmness		TSS %		T Acidity %		TSS Acid ratio	
D.B.H	St. P.	Fst. S.	Sec. S.	Fst. S.	Sec. S.	Fst. S.	Sec. S.	Fst. S.	Sec. S.	Fst. S.	Sec. S.	Fst. S.	Sec. S.
21	0	0.0	0.0	G	G	38	42	10.3	8.5	1.49	1.94	7	4
	2	14.9	11.3	SH	SH	41	45	11.3	9.5	1.56	2.11	7	5
	4	25.2	21.6	SH	SH	42	48	11.6	10.5	1.52	2.09	8	5
14	0	0.0	0.0	G	G	37	41	11.0	9.9	0.93	1.17	12	9
	2	9.2	8.4	SH	SH	40	46	12.3	11.2	0.99	1.15	12	10
	4	14.5	12.5	SH	SH	39	45	12.1	11.5	0.97	1.22	13	9
7	0	0.0	0.0	G	G	33	38	14.1	13.8	0.72	0.89	20	16
	2	5.8	6.2	G	G	35	42	14.9	14.3	0.75	0.92	20	16
	4	8.6	10.4	G	SH	36	43	15.3	14.6	0.75	0.88	20	17
0	0	0.0	0.0	G	G	32	36	15.5	15.3	0.60	0.64	26	24

G	Good
Fst. S.	First Season

SH	Shrinkage
Sec. S.	Second Season

(Table 3): Effect of fumigation with SO2 and storage temperatura on decay percentage of Early Superior table grapes during seasoos (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	0.0	0.0	0.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0
	4	1.2	0.0	0.6		14	7.6	0.6	4.1	1.2	0.3	0.7	2.40
	7	7.8	2.3	5.0		28	15.5	2.2	8.9	3.6	0.4	2.0	5.45
	11	13.0	4.5	8.6		42	30.0	6.0	15.0	14.1	1.8	7.9	12.98
	14	26.4	11.4	18.9		56	36.1	9.9	24.0	20.9	4.4	12.6	18.24
St. Per	18	52.6	27.8	40.0	St. Per	70	50.0	13.3	31.6	33.3	9.7	21.5	28.58
Means		16.82	7.60	12.21	Means		23.52	5.34	14.43	12.12	2.77	7.44	
Second Season (2003)													
	0	0.0	0.0	0.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0
	4	1.8	0.2	1.0		14	0.2	0.0	0.1	0.2	0.0	0.1	0.10
	7	2.7	0.7	1.7		28	2.8	1.0	1.9	3.6	0.3	1.9	1.86
	11	8.9	3.8	6.3		42	12.8	3.9	8.4	12.5	1.5	7.0	7.68
	14	24.8	6.2	15.4		56	26.7	5.9	16.3	24.8	5.6	15.2	15.73
St. Per	18	52.3	12.9	32.6	St. Per	70	36.4	10.2	24.2	33.5	8.8	21.2	22.73
Means		13.04	3.93	9.49	Means		13.45	3.51	8.48	12.41	2.70	7.56	

L S D value. At 5 %	SO2 Tr.	St. Per.	Inter.3	L S D value. At 5 %	St. Tem.	SO2 Tr.	St. Per.	Inter. 1	Inter. 2	Inter. 3	Inter 4
First Season	1.47	2.54	3.6	First Season	1.14	1.14	1.98	1.61	2.8	2.6	2.98
Second Season	2.34	4.06	5.74	Second Season	N.S.	1.21	2.1	N.S.	N.S.	2.97	N.S.

		No SO2	Without SO2 treatments	Inter. 1	St. Tem. X SO2 Tr.	Inter. 3	SO2 Tr. X St.Per.	
		SO2 T.	With SO2 treatments	Inter. 2	St. Tem. X St.Per.	Inter. 4	St. Tem. X SO2 Tr. X St.Per	

(Table 4): Effect of fumigation with SO2 and storage temperature on weight loss percentage of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			9° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	0.0	0.0	0.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0
	4	1.2	0.9	1.0		14	2.0	1.1	1.6	1.8	1.5	1.7	1.61
	7	4.6	2.9	3.8		28	3.4	1.9	2.6	2.4	2.1	2.2	2.42
	11	5.9	4.6	5.2		42	6.3	3.4	4.9	4.0	2.7	3.3	4.10
	14	9.5	7.5	8.5		56	9.2	5.9	7.6	8.7	3.9	4.8	6.19
St. Per	19	14.8	9.5	12.0	St. Per	70	11.9	7.9	9.9	10.8	5.6	8.1	9.97
Means		5.98	4.22	5.09	Means		23.82	5.34	14.43	12.12	2.77	7.44	
Second Season (2003)													
	0	0.0	0.0	0.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0
	4	1.5	1.4	1.4		14	1.8	1.2	1.5	1.8	1.1	1.4	1.45
	7	3.7	3.1	3.4		28	3.1	2.3	2.7	3.4	2.4	2.9	2.79
	11	5.6	4.7	5.1		42	4.4	3.6	4.0	4.3	3.5	3.9	3.96
	14	8.1	6.3	6.7		56	6.4	5.0	5.7	5.7	4.4	5.0	5.37
St. Per	19	12.1	7.9	10.0	St. Per	70	8.9	5.7	7.3	8.2	5.4	6.8	7.04
Means		5.17	3.74	4.46	Means		4.11	2.95	3.53	3.88	2.81	3.34	

L S D value. At 5 %	SO2 Tr.	St. Per.	Inter.3	L S D value. At 5 %	St. Tem.	SO2 Tr.	St. Per.	Inter. 1	Inter. 2	Inter. 3	Inter 4
First Season	0.97	1.68	2.37	First Season	0.5	0.5	0.87	N.S.	1.23	1.23	N.S.
Second Season	0.43	0.74	1.04	Second Season	N.S.	0.27	0.47	N.S.	N.S.	0.67	N.S.

		No SO2	Without SO2 treatments	Inter. 1	St. Tem. X SO2 Tr.	Inter. 3	SO2 Tr. X St Per	
		SO2 T.	With SO2 treatments	Inter. 2	St. Tem. X St.Per.	Inter. 4	St. Tem. X SO2 Tr X St.Per	

(Table 5): Effect of fumigation with SO2 and storage temperature on shattering percentage of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	0.0	0.0	0.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0
	4	0.9	0.3	0.6		14	2.3	1.0	1.6	2.1	0.9	1.5	1.56
	7	2.8	1.7	2.2		28	3.1	1.4	2.2	2.8	1.2	2.0	2.13
	11	5.6	3.3	4.4		42	4.2	2.0	3.1	3.7	1.9	2.8	2.97
	14	16.3	6.2	11.2		56	8.7	3.0	5.8	6.0	2.6	4.3	5.08
St. Per	18	23.8	11.3	17.5	St. Per	70	13.2	4.0	8.6	10.4	3.6	7.0	7.79
Means		8.22	3.78	6.00	Means		5.25	1.90	3.57	4.18	1.70	2.94	
Second Season (2003)													
	0	0.0	0.0	0.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0
	4	2.6	1.4	2.0		14	2.3	0.9	1.6	1.6	0.7	1.1	1.35
	7	3.6	2.3	3.0		38	3.1	1.6	2.4	2.9	1.2	2.0	2.19
	11	5.2	3.6	4.4		42	6.1	3.3	4.2	3.7	2.0	2.8	3.52
	14	9.7	6.2	8.0		56	12.9	5.6	9.3	10.7	3.8	7.3	8.26
St. Per	18	18.3	8.3	13.3	St. Per	70	21.3	8.1	14.7	20.0	5.2	12.6	13.65
Means		6.56	3.63	5.10	Means		7.45	3.25	5.35	6.48	2.15	4.31	

L S D value. At 5 %	SO2 Tr.	St. Per.	Inter.3	L S D value. At 5 %	St. Tem.	SO2 Tr.	St. Per.	Inter. 1	Inter. 2	Inter. 3	Inter.4
First Season	1.39	2.41	3.41	First Season	0.3	0.3	0.52	0.42	0.73	0.73	1.03
Second Season	0.89	1.54	2.18	Second Season	0.52	0.52	0.91	N.S.	N.S.	1.29	N.S.

		No SO2	Without SO2 treatments	Inter. 1	St. Tem. X SO2 Tr.	Inter. 3	SO3 Tr. X St.Per
		SO2 T.	With SO2 treatments	Inter. 2	St. Tem. X St.Per.	Inter. 4	St. Tem. X SO2 Tr. X St.Per

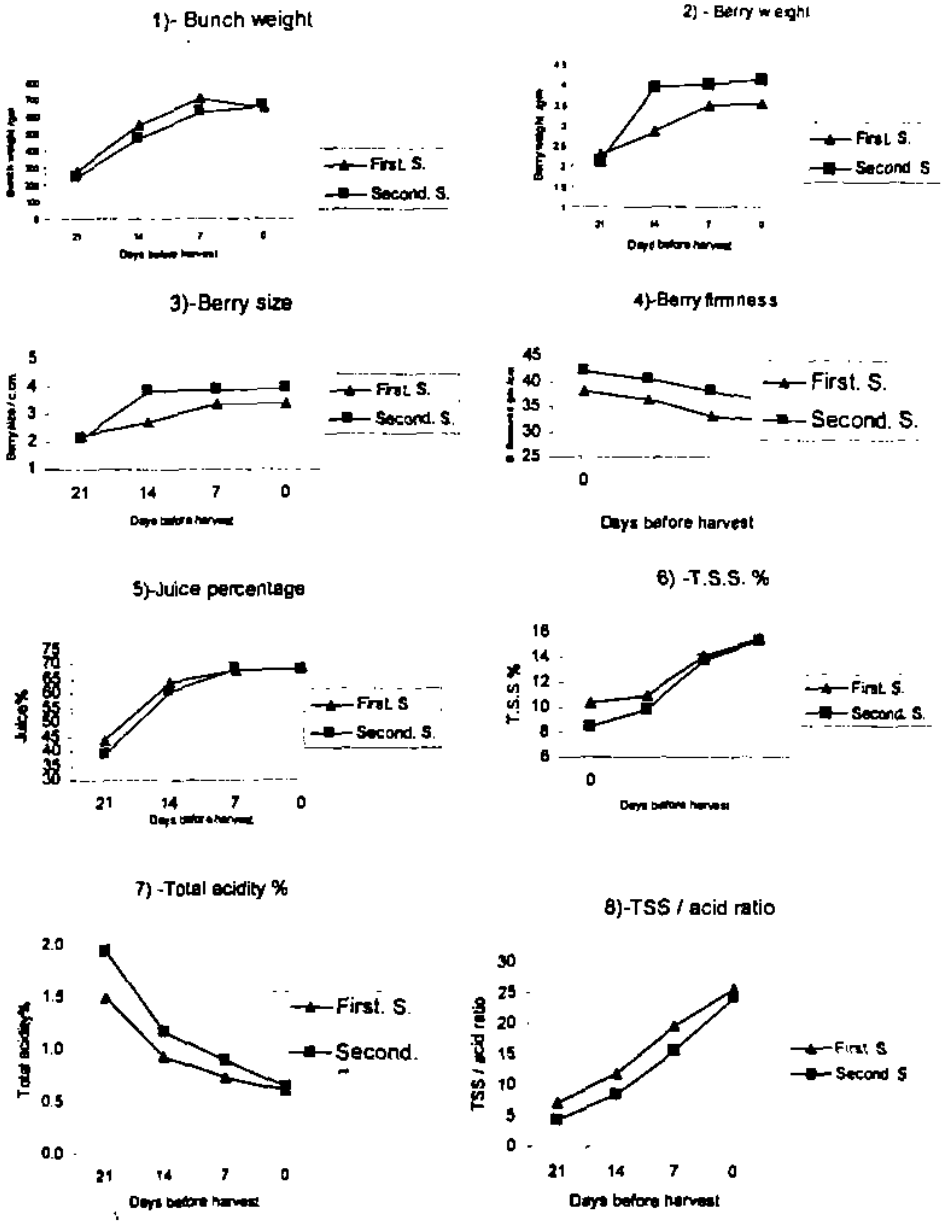
(Table 6): Effect of fumigation with SO2 and storage temperature on total spoilage percentage of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	0.0	0.0	0.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0
	4	3.2	1.2	2.2		14	11.9	2.6	7.2	5.1	2.7	3.9	5.57
	7	15.2	6.8	11.0		28	22.0	5.5	13.7	8.8	3.7	6.3	10.00
	11	24.5	12.3	18.4		42	40.5	11.5	26.0	21.8	6.4	14.1	20.02
	14	52.1	25.1	38.6		56	56.0	18.8	37.4	32.3	10.9	21.6	29.51
St. Per	18	90.9	48.2	69.6	St. Per	70	75.1	25.2	50.1	54.2	18.9	36.5	43.33
Means		30.29	15.61	20.30	Means		34.23	10.59	22.41	20.38	7.09	13.73	
Second Season (2003)													
	0	0.0	0.0	0.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0
	4	5.8	3.0	4.4		14	4.3	2.1	3.2	3.4	1.8	2.6	2.90
	7	10.0	6.1	8.0		28	8.8	4.9	6.8	9.8	3.8	6.8	6.83
	11	19.7	11.8	15.8		42	22.4	10.8	16.6	20.5	7.0	13.7	15.18
	14	42.4	17.8	30.1		56	46.0	16.5	31.2	41.2	13.8	27.5	29.36
St. Per	18	82.8	29.1	56.0	St. Per	70	68.5	24.0	46.3	61.7	19.4	40.6	43.42
Means		26.79	11.31	19.04	Means		25.01	9.70	17.36	22.75	7.65	15.20	25.01

L S D value. At 5 %	SO2 Tr.	St. Per.	Inter.3	L S D value. At 5 %	St. Tem.	SO2 Tr.	St. Per.	Inter 1	Inter. 2	Inter. 3	Inter 4
First Season	2.8	4.84	6.85	First Season	1.03	1.03	1.78	1.45	2.51	2.51	3.55
Second Season	2.7	4.68	6.62	Second Season	1.56	1.56	2.7	N.S	N.S	3.82	N.S

		No SO2	Without SO2 treatments	Inter. 1	St. Tem. X SO2 Tr.	Inter. 3	SO2 Tr X St.Per	
		SO2 T.	With SO2 treatments	Inter. 2	St. Tem. X St.Per.	Inter. 4	St. Tem. X SO2 Tr X St.Per	

Figure (1) Physical and chemical properties changes of Early Superior grapes during growth and maturation , (2002-2003).



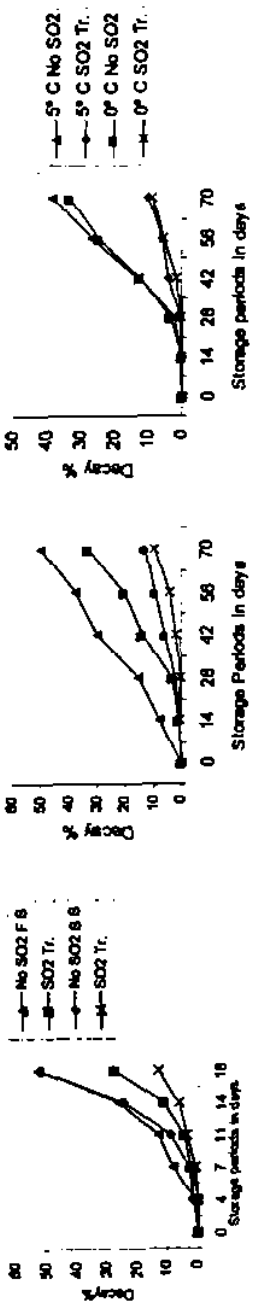


Figure (2) Effect of sulfur dioxide and storage temperature on decay percentage of Early Superior table grapes during storage, (A, at room temperature and B , at 5°c and 0°c temperature).

Figure (3) Effect of sulfur dioxide and storage temperature on total spoilage percentage of Early Superior table grapes during storage, (A, at room temperature and B , at 5°c and 0°c temperature).

These results are in agreement with those obtained by Wasel (1985), Asker (1988), Dhillon and Sandhu (1990), Smilinick *et al* (1990), Auger *et al* (1991), Rould *et al* (1991), Morris *et al* (1992) Mustoren (1992), Sandhu *et al* (1992), Mohamed (1994), Soylemezoglu *et al* (1994), Cenci and Ferrreiral (1996), Yun *et al* (1995), Sarig *et al* (1996), Castro *et al* (1998), Ling *et al* (1998), Baneh *et al* (1999), Ling *et al* (1991), Munoz *et al* (2000) and Mohamed (2002). They reported that post harvest SO_2 fumigation significantly reduced the incidence of decay, shatter, water loss and total spoilage in grapes during storage.

Berry firmness:

According to data shown in Table (7), berry firmness significantly decreased with the extension of storage period either at room temperature or at cold storage. The same data cleared that, there was no significant differences between berry firmness of grapes either stored at 5°c or 0°c.

Regarding post harvest SO_2 treatment, it is clear that, fumigation with SO_2 significantly reduced the softening rate of grape berry firmness, regardless of storage temperature.

These results are in line with the findings of Mansour *et al* (1984) and Mohamed (1994).

Bunch freshness:

Data illustrated in Table(8) cleared that, Bunch freshness (the average of stem color, dryness and berry appearance) significantly deteriorated with prolonging the storage period. Data also illustrated that SO_2 post harvest treatment significantly reduced the deterioration rate of bunch freshness. Moreover, the low storage temperature significantly decreased the deterioration incidence of bunch freshness. These results are in harmony with those obtained by Mansour *et al* (1984), Mustonen (1992), Morris *et al* (1992) Mohamed (1994), Soylemezoglu *et al* (1994), Kim (1994), Baneh *et al* (1999), Mohamed (2002).

Juice percentage:

It is obvious from data shown in Table (9) that although, juice percentage of Early Superior grapes decreased with prolonging storage period, there were no significant differences between juice percentage content of grapes either stored at 5°c or at 0°c and either fumigated with SO_2 or not fumigated with SO_2.

Total soluble solids, Total acidity and T.S.S / total acidity ratio:

Data recorded in Tables (10, 11 and 12) and Figures (4 and 5) cleared that , total soluble solids increased gradually and significantly during the first periods of storage till reached the maximum value then began to decrease until the end of the storage period. Also T.S.S / total acidity ratio increased gradually and significantly during storage. While, total acidity decreased till reached the lowest value then began to increase until the end of the storage period.

(Table 7): Effect of fumigation with SO2 and storage temperature on berry firmness (gm /cm2) of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	31.9	31.9	31.9		0	31.9	31.9	31.9	31.9	31.9	31.9	31.9
	4	29.8	29.4	29.6		14	32.8	32.9	32.9	30.1	32.2	31.2	32.00
	7	26.9	28.4	27.7		28	29.9	31.3	30.6	30.2	31.5	30.9	30.73
	11	26.2	27.1	26.7		42	26.2	30.2	28.2	26.3	29.0	27.7	27.93
	14	24.5	28.0	26.3		56	25.2	28.6	26.9	23.7	27.6	25.7	26.28
St. Per	18	21.6	26.4	24.0	St. Per	70	20.2	29.4	24.8	22.3	26.2	24.3	24.53
Means		26.82	28.53	27.68	Means		27.70	30.72	29.21	27.42	29.73	28.58	
Second Season (2003)													
	0	35.9	35.9	35.9		0	35.9	35.9	35.9	35.9	35.9	35.9	35.9
	4	32.9	34.4	33.7		14	33.1	35.0	34.1	34.1	36.1	35.1	34.58
	7	30.7	33.3	32.0		28	32.3	35.2	33.8	32.7	35.4	34.1	33.90
	11	28.2	32.4	30.3		42	31.9	33.8	32.9	31.2	34.6	32.9	32.88
	14	25.5	30.7	28.1		56	28.5	32.5	30.5	30.0	33.5	31.8	31.13
St. Per	18	23.2	28.0	25.6	St. Per	70	25.8	31.1	28.5	26.6	28.9	27.8	28.10
Means		29.40	32.45	30.93	Means		31.25	33.92	32.58	31.75	34.07	32.91	

L S D value At 5 %	SO2 Tr.	St. Per.	Inter.3	L S D value. At 5 %	St. Tem.	SO2 Tr.	St. Per.	Inter. 1	Inter. 2	Inter 3	Inter 4
First Season	1.64	2.85	N.S.	First Season	N.S.	0.99	1.71	N.S.	N.S	2.42	N.S.
Second Season	1.52	2.63	N.S	Second Season	N.S.	1.01	1.75	N.S	N.S.	N.S.	N.S

	No SO2	Without SO2 treatments	Inter. 1	St. Tem. X SO2 Tr	Inter 3	SO2 Tr. X St.Per	
	SO2 T	With SO2 treatments	Inter 2	St. Tem X St.Per.	Inter. 4	St. Tem. X SO2 Tr. X St.Per.	

(Table 8): Effect of fumigation with SO2 and storage temperature on bunch general appearance of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	1.0	1.0	1.0		0	1.0	1.0	1.0	1.0	1.0	1.0	1
	4	1.8	1.1	1.4		14	1.3	1.0	1.2	1.1	1.0	1.1	1.11
	7	2.7	1.9	2.3		28	2.3	1.2	1.8	2.0	1.0	1.5	1.64
	11	3.7	2.6	3.1		42	3.0	1.9	2.4	2.7	1.2	1.9	2.19
	14	4.0	3.4	3.7		56	3.9	2.7	3.3	3.4	2.3	2.9	3.08
St. Per	18	4.0	3.9	3.9	St. Per	70	4.0	3.4	3.7	4.0	3.0	3.5	3.61
Means		2.65	2.31	2.58	Means		2.59	1.87	2.23	2.37	1.59	1.98	
Second Season (2003)													
	0	1.0	1.0	1.0		0	1.0	1.0	1.0	1.0	1.0	1.0	1
	4	1.8	1.0	1.4		14	1.3	1.0	1.2	1.2	1.0	1.1	1.14
	7	2.8	1.8	2.3		28	2.3	1.3	1.8	2.0	1.1	1.6	1.89
	11	3.8	2.7	3.2		42	3.0	2.3	2.7	2.7	1.9	2.3	2.47
	14	4.0	3.7	3.8		56	3.8	2.8	3.3	3.6	2.6	3.1	3.17
St. Per	18	4.0	3.9	3.9	St. Per	70	4.0	3.4	3.7	4.0	3.0	3.5	3.61
Means		2.89	2.33	2.61	Means		2.57	1.98	2.28	2.41	1.76	2.08	

L S D value. At 5 %	SO2 Tr.	St. Per.	Inter 3	L S D value. At 5 %	St Tem.	SO2 Tr.	St. Per.	Inter. 1	Inter. 2	Inter 3	Inter.4
First Season	0.16	0.28	0.40	First Season	0.11	0.11	0.19	N.S.	N.S.	0.27	N.S.
Second Season	0.14	0.25	0.35	Second Season	0.15	0.15	0.26	N.S.	N.S.	0.37	N.S

	No SO2	Without SO2 treatments	Inter. 1	St. Tem. X SO2 Tr.	Inter. 3	SO2 Tr X St.Per	
	SO2 Tr.	With SO2 treatments	Inter. 2	St. Tem. X St.Per.	Inter 4	St. Tem X SO2 Tr X St.Per	

(Table 9): Effect of fumigation with SO2 and storage temperature on juice percentage of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	69.7	69.0	69.4		0	69.0	69.0	69.0	69.0	69.0	69.0	69.01
	4	69.2	71.3	70.3		14	70.8	73.4	72.1	71.0	70.8	70.9	71.48
	7	73.2	69.1	71.1		28	70.5	71.2	70.9	68.6	71.0	69.8	70.33
	11	67.9	71.8	69.9		42	66.2	70.3	69.2	66.9	70.6	68.8	69.01
	14	69.2	69.6	69.4		56	69.8	69.2	69.5	67.1	69.5	68.3	68.88
St. Per	18	63.2	67.3	65.3	St. Per	70	64.5	68.0	66.3	63.2	68.0	65.6	65.93
Means		68.74	69.70	69.22	Means		68.80	70.16	69.49	67.63	69.81	68.72	
Second Season (2003)													
	0	68.2	68.2	68.2		0	68.2	68.2	68.2	68.2	68.2	68.2	68.21
	4	69.9	70.1	70.0		14	69.2	71.0	70.1	72.2	70.0	71.1	70.58
	7	64.7	69.6	67.1		28	72.4	68.2	70.3	67.7	69.1	68.4	69.37
	11	71.1	69.9	70.5		42	70.7	70.0	70.4	64.3	66.9	65.6	68.48
	14	63.5	67.4	65.5		56	64.1	67.4	65.8	65.0	68.0	66.5	66.13
St. Per	18	62.0	66.8	64.4	St. Per	70	61.5	64.1	62.8	61.9	64.9	63.4	63.10
Means		66.56	68.67	67.61	Means		67.67	68.16	67.92	66.56	68.19	67.38	

L S D value. At 5 %	SO2 Tr.	St Per.	Inter.3	L S D value. At 5 %	St Tem.	SO2 Tr.	St. Per.	Inter. 1	Inter. 2	Inter 3	Inter 4
First Season	N.S	N.S	N.S.	First Season	N.S.	N.S	N.S.	N.S	N.S.	N.S	N.S
Second Season	N.S	N.S	N.S	Second Season	N.S	N.S	3.98	N.S	N.S	N.S	N.S
	No SO2	Without SO2 treatments		Inter. 1	St Tem X SO2 Tr			Inter 3	SO2 Tr X St.Per.		
	SO2 T.	With SO2 treatments		Inter 2	St. Tem. X St.Per			Inter. 4	St. Tem. X SO2 Tr X St.Per		

(Table 10): Effect of fumigation with SO2 and storage temperature on total soluble solid % of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	15.5	15.5	15.5		0	15.5	15.5	15.5	15.5	15.5	15.5	15.5
	4	15.9	15.9	15.9		14	15.8	16.0	15.9	15.8	16.1	16.0	15.93
	7	16.3	16.0	16.1		28	16.2	15.9	16.0	16.4	16.0	16.2	16.13
	11	16.5	16.3	16.4		42	16.3	16.2	16.2	16.6	16.6	16.6	16.41
	14	16.4	16.4	16.4		56	16.5	16.4	16.4	16.5	16.7	16.6	16.49
St. Per	18	16.0	16.8	16.4	St. Per	70	16.2	16.8	16.5	16.2	16.8	16.5	16.49
Means		16.06	16.14	16.11	Means		16.07	16.12	16.09	16.16	16.27	16.22	
Second Season (2003)													
	0	15.3	15.3	15.3		0	15.3	15.3	15.3	15.3	15.3	15.3	15.3
	4	15.7	15.6	15.7		14	15.7	15.8	15.7	15.8	15.7	15.8	15.73
	7	16.0	15.9	16.0		28	15.8	16.1	16.0	16.1	16.4	16.2	16.10
	11	16.0	16.0	16.0		42	16.0	16.5	16.2	16.5	16.3	16.4	16.33
	14	16.0	16.5	16.3		56	16.4	16.6	16.5	15.9	16.7	16.3	16.38
St. Per	18	16.1	16.4	16.3	St. Per	70	15.9	16.7	16.3	15.6	16.8	16.2	16.25
Means		15.86	15.96	15.91	Means		15.84	16.14	15.99	15.88	16.20	16.04	

L S D value. At 5 %	SO2 Tr.	St. Per.	Inter.3	L S D value. At 5 %	St. Tem	SO2 Tr.	St. Per.	Inter. 1	Inter. 2	Inter. 3	Inter.4
First Season	N.S	0.51	N.S.	First Season	N.S.	N.S.	0.31	N.S	N.S	N.S	N.S
Second Season	N.S.	0.5	N.S.	Second Season	N.S.	0.16	0.28	N.S	N.S	0.39	N.S

		No SO2	Without SO2 treatments	Inter. 1	St. Tem. X SO2 Tr.	Inter 3	SO2 Tr. X St.Per.
		SO2 T	With SO2 treatments	Inter 2	St. Tem X St.Per.	Inter 4	St. Tem. X SO2 Tr X St.Per.

(Table 11): Effect of fumigation with SO2 and storage temperature on total acidity percentage of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	0.60	0.60	0.60		0	0.60	0.60	0.60	0.60	0.60	0.60	0.60
	4	0.63	0.62	0.62		14	0.62	0.62	0.62	0.61	0.62	0.62	0.62
	7	0.59	0.60	0.60		28	0.60	0.61	0.60	0.59	0.61	0.60	0.60
	11	0.57	0.60	0.58		42	0.57	0.59	0.58	0.58	0.60	0.59	0.58
	14	0.61	0.58	0.60		56	0.56	0.57	0.56	0.57	0.58	0.57	0.57
St. Per	18	0.62	0.57	0.59	St. Per	70	0.61	0.56	0.59	0.61	0.57	0.59	0.59
Means		0.60	0.59	0.60	Means		0.59	0.59	0.59	0.59	0.59	0.59	
Second Season (2003)													
	0	0.64	0.64	0.64		0	0.64	0.64	0.64	0.64	0.64	0.64	0.63
	4	0.66	0.66	0.66		14	0.65	0.64	0.64	0.65	0.66	0.65	0.65
	7	0.64	0.65	0.64		28	0.61	0.63	0.62	0.63	0.64	0.64	0.63
	11	0.61	0.63	0.62		42	0.59	0.62	0.61	0.61	0.62	0.62	0.61
	14	0.60	0.62	0.61		56	0.63	0.60	0.61	0.59	0.60	0.60	0.61
St. Per	18	0.66	0.61	0.64	St. Per	70	0.64	0.59	0.61	0.64	0.60	0.62	0.62
Means		0.63	0.63	0.63	Means		0.63	0.62	0.62	0.63	0.63	0.63	

L S D value. At 5 %	SO2 Tr	St Per.	Inter.3	L S D value. At 5 %	St. Tem.	SO2 Tr	St. Per.	Inter. 1	Inter. 2	Inter. 3	Inter.4
First Season	N.S	N.S.	N.S	First Season	N.S	N.S.	0.026	N.S	N.S	0.037	N.S
Second Season	N.S	0.04	N.S	Second Season	N.S.	N.S.	0.008	N.S.	N.S.	0.012	N.S

		No SO2	Without SO2 treatments	Inter. 1	St. Tem X SO2 Tr	Inter. 3	SO2 Tr. X St.Par	
		SO2 T.	With SO2 treatments	Inter 2	St. Tem X St.Per	Inter 4	St. Tem X SO2 Tr X St.Par.	

(Table 12): Effect of fumigation with SO2 and storage temperature on TSS / total acidity ratio of Early Superior table grapes during seasons (2002 and 2003)

Storage Tem.		Room Temperature			Storage Tem.		5° C			0° C			Means
Treatments		No SO2	SO2 Tr.	Means	Treatments		No SO2	SO2 Tr.	Means	No SO2	SO2 Tr.	Means	
First Season (2002)													
	0	25.7	25.7	25.7		0	25.7	25.7	25.7	25.7	25.7	25.7	25.73
	4	25.4	25.9	25.7		14	25.7	25.9	25.8	25.8	26.1	25.9	25.85
	7	27.7	26.6	27.1		28	27.2	26.1	26.6	27.6	26.5	27.1	26.85
	11	29.2	27.2	28.2		42	28.7	27.4	28.0	28.6	27.6	28.3	28.18
	14	26.9	28.3	27.6		56	29.7	28.8	29.2	29.0	29.0	29.0	29.11
St. Per	18	25.7	29.6	27.7	St. Per	70	28.6	29.9	28.2	26.8	29.4	28.1	28.17
Means		26.77	27.22	26.99	Means		27.26	27.30	27.28	27.28	27.43	27.35	
Second Season (2003)													
	0	24.2	24.2	24.2		0	24.2	24.2	24.2	24.2	24.2	24.2	24.22
	4	23.7	23.7	23.7		14	24.2	24.6	24.4	24.3	24.0	24.1	24.26
	7	25.2	24.6	24.9		28	25.9	25.8	25.8	25.8	25.6	25.6	25.71
	11	26.1	25.4	25.8		42	26.9	26.4	26.7	27.3	26.2	26.7	26.70
	14	26.7	26.5	26.6		56	26.0	27.8	26.9	26.9	27.6	27.3	27.08
St. Per	18	24.3	27.0	25.6	St. Per	70	24.7	28.6	26.6	24.4	28.2	26.3	26.48
Means		25.05	25.23	25.14	Means		25.32	26.23	25.78	25.44	25.96	25.70	

L S D value At 5 %	SO2 Tr.	St. Per.	Inter.3	L S D value At 5 %	St. Tem.	SO2 Tr.	St. Per.	Inter. 1	Inter. 2	Inter 3	Inter 4
First Season	N.S.	1.52	2.15	First Season	N.S	N.S.	0.96	N.S	N.S.	1.36	N.S
Second Season	N.S.	1.64	N.S.	Second Season	N.S.	0.56	0.97	N.S.	N.S.	1.37	N.S.

		No SO2	Without SO2 treatments	Inter. 1	St. Tem. X SO2 Tr.	Inter 3	SO2 Tr. X St.Per.	
		SO2 Tr.	With SO2 treatments	Inter. 2	St. Tem. X St.Per.	Inter 4	St. Tem X SO2 Tr. X St.Per	

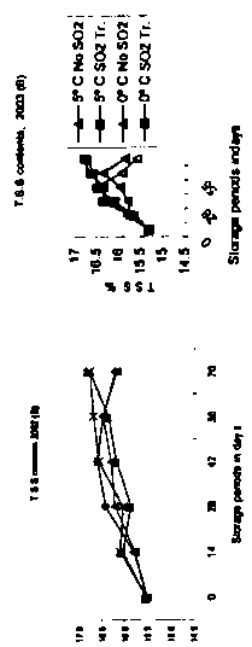


Figure (4) Effect of sulfur dioxide and storage temperature on total soluble solids contents of Early Superior table grapes during storages, (A, at room temperature and B , at 5°c and 0°c temperature).

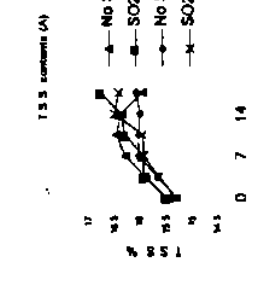


Figure (5) Effect of sulfur dioxide and storage temperature on total acidity contents of Early Superior table grapes during storage, (A, at room temperature and B , at 5°c and 0°c temperature).

Concerning the effect of post harvest SO_2 treatments, data also indicated that, post harvest SO_2 treatments had no effect on total soluble solids, total acidity content and *total soluble solids / total acidity ratio of grapes during* storage. However, data illustrated in Figures (4, 5) cleared that post harvest fumigation with SO_2 forbid or delayed the reverse point in the total soluble solid and total acidity of grapes during storage.

These results are in accordance with those found by Mohamed (1994), and (2002) and partially agree with those reported by Asker et al (1988), Morris et al (1992), Cenci and Ferreira (1996), as they mentioned that SO_2 fumigation had no effect on TSS and *total acidity. On contrast these* results disagree with those reported by Yiqiang (1998) who mentioned that, grapes fumigated with SO^2 had the highest TSS and TSS / acid ratio contents *and the lowest total acidity contents.*

The effect of storage temperature:

In brief, from all the above tables it is concluded that, storage at the lowest temperature (0°c) significantly maintained grape fruits quality and increased storability of grapes compared with higher storage temperatures (room temperature and 5°c) as expressed by decreasing decay, shatter, weight loss and spoilage incidence. Moreover, keeping all fruit quality parameters *(berry firmness, bunch freshness, TSS and total acidity contents)* at the proper levels. These results are in harmony with the finding of Kim (1994), Mohamed (1994) and Munoz (2002).

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دراسات فسيولوجية لتحديد مرحلة اكتمال النمو والقدرة التخزينية لعنب المائدة صنف ايرلى سوبريور

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معهد بحوث البساتين- قسم بحوث تداول الفاكهة

اجري هذا البحث خلال موسمي ٢٠٠٢&٢٠٠٣بمعهد بحوث البساتين قسم بحوث تداول الفاكهة،تم الحصول على العناقيد من مزرعة خاصة بطريق القاهرة-الإسكندرية الصحراوي. أخذت عينات دورية من الثمار ابتداء من الأسبوع الثاني من شهر مايو بغرض تحديد مرحلة اكتمال النمو. عند الوصول الى مرحلة اكتمال النمو قطفت الثمار ونقلت مباشرة إلى المعمل في الصباح الباكر لدراسة القدرة التخزينية للصنف. في المعمل تم فرز العناقيد وتعبئتها داخل كراتين (٢كجم / كرتونة) مع التبطين بالبولي ايثلين المثقب (٤٠ميكرون) نصف كراتين الثمار عوملت بمولدات ثاني أكسيد الكبريت والنصف الأخر لم يعامل . تم تخزين الثمار على درجة حرارة الغرفة (٢٧±٥°م) وعلى درجة حرارة ٥ °م وصفر مئوى (٩٠ : ٩٥ % رطوبة نسبية) لمدة ١٨ و٧٠و٧٠ يوما على التوالى بحيث أن كل درجة من درجات التخزين الثلاثة تحتوى على كراتين عوملت بـ ثاني أكسيد الكبريت والأخرى لم تعامل .

يمكن اعتبار الصنف ايرلى سوبريور مكتمل النمو في الأسبوع الثاني من شهر يوليو (المعاملة بكاسرات السكون ضرورية عندئذ) وعندها تكون نسبة المواد الصلبة الذائبة اكبر من١٥% ونسبة الحموضة الكلية اقل من ٠,٦٦% ونسبة المواد الصلبة الذائبة إلى الحموضة الكلية اكبر من ٢٥.

ولقد تبين من هذة الدراسة إن استخدام مولدات ثاني أكسيد الكبريت ضروريه للمحافظة على حيوية الثمار سواء إثناء الشحن أو التخزين لفترات طويلة وعلى الأخص عندما تزيد فترة الشحن عن ٢١ يوما. أوضحت الدراسة أن الصنف ايرلى سوبر يور حساس للحرارة العالية حيث لم تتعدى الفترة التخزينية على درجة حرارة الغرفة ١٢ يوما حتى مع استخدام مولدات ثاني أكسيد الكبريت. أيضا أوضحت هذة الدراسة أن تخزين الثمار على درجة الصفر المئوي كان لة اكبر الأثر في تحسين القدرة التخزينية للصنف ايرلى سوبريور مقارنة بالتخزين على درجة٥°م خاصة في الموسم الأول (٢٠٠٢) ومع هذا فانه خلال المراحل ألا ولى من التخزين (اقل من ٤٥يوما) فان استخدام ٥°م درجة مئوي يكون كافيا للحفاظ على حيوية الثمار. أما في حالة الرغبة في التخزين أو الشحن لمدة أطول من تلك الفترة فأنة من الضروري عندئذ استخدام درجة الصفر المئوي. وفى كل هذة الحالات فان استخدام ثاني أكسيد الكبريت اصبح ضروريا للحد من انتشار الاصابات الفطرية.