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THE USE OF THE BIOFERTILIZER PHOSPHOREIN TO REDUCE THE RATE OF MINERAL P FERTILIZATION IN THOMPSON SEEDLESS VINEYARDS

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ABSTRACT: In a field experiment during the two seasons of 2003 and 2004, mature Thompson Seedless grapevines grown under conditions of sandy clay loam soil and flood irrigation received the usual dose of phosphorus fertilization in the region; i.e., 100 kg/*fed* of calcium superphosphate 15.5 %P_2O_5 (control), or different combinations between lower doses of calcium superphosphate (75, 50, 25 or 0 kg /*fed*) each with 4 or 8 kg/*fed* of the biofertilizer phosphorein. Evaluation of the tested treatments was carried out through parameters of the yield components, bunch characteristics, berry physical properties and juice chemical constituents as well as leaf area, weight, photosynthetic pigments and N, P and K contents. The obtained results revealed suppressive effect of the combinations between 0 and 25kg calcium superphosphate/*fed* each with 4 or 8 kg phosphorein/*fed* on many of the considered vine activities, as compared with the control. The early disefficacy of these treatments; i.e., in the first and second seasons, of application ment that both rates of phosphorein failed to compensate the lack or the low rate of mineral P fertilization. However, the combinations between the medium rates of calcium superphosphate; i.e., 75 and 50 kg/*fed* each with 4 or 8 kg/*fed* phosphorein were nearly as efficient as the control regarding most of the studied parameters. This ment that these treatments saved 25 or 50 kg calcium superphosphate. As fertilization experiments usually need many years, it could be suggested to continue the evaluation of the combined P fertilization treatments of 75 and 50 kg/*fed* calcium superphosphate, each with 4 and 8 kg/*fed* of the biofertilizer phosphorein on Thompson Seedless grapevines.

Key words: Grapevines, calcium superphosphate and biofertilizers.

INTRODUCTION

Grapes are the most popular of deciduous fruits in Egypt and the world. Egyptian vineyards greatly expanded in the last few decades and reached 159,929 *fed*s (Ministry of Agric. Statistics, 2004). Thompson Seedless grape is still the most popular for the Egyptians.

Fertilization is very essential for good yield and quality of grapes. Phosphorus plays indispensable role in the enzyme system necessary for energy transformation in photosynthesis and respiration (Marschner, 1995). The large amounts of mineral fertilizers, including phosphorus caused a considerable environmental pollution. This is more prominent with mineral P fertilization since most of the added calcium phosphate is fixed in the soil and become unavailable to plant absorption due to some soil characteristics as the high pH or high calcium carbonate content. Thus, Hendrix (1967) found that at pH 4, bean plants absorbed phosphate at a 10 fold higher rate than at a pH of 8.7. Also, Hai and Laudelout (1966) reported a maximum P uptake rate by rice roots at pH 5.6.

Biofertilization is very safe to human, animals and can reduce environmental pollution. The biofertilizer phosphorein contains the active microorganisms (bacteria) *Bacillus megatherium* that hydrolyzed the insoluble phosphate content of soil to be in a ready from for plant nutrition (Richardson, 2001).Also, *Bacillus pumilus* and *Bacillus licheniformis*, isolated from the rhizosphere of older (*Alnus glutinosa*), can produce high amounts of physiologically active gibberellins (Gutierez-Manero *et al.*, 2001).

Application of the biofertilizer phosphorein was previously found to improve growth and nutritional status of trees as well as the yield and fruit quality of some fruit trees and other plants (Boutros *et al.*, 1987a and b on citrus; Ahmed *et al.*, 1997 on Red Roomy grapevines; El-Sheekh, 1997 on onion and Sundara *et al.*, 2002).

This study aimed mainly to minimize the application of mineral phosphorus fertilization by using the biofertilizer named phosphorein. Nine combined treatments comprising four levels of calcium superphosphate (15.5 %) P_2O_5; i.e., 0, 25, 50, 75 and 100 kg/*fed* and three levels of phosphorein; i.e., 0, 4, and 8 kg /*fed* were investigated

MATERIALS AND METHODS

This investigation has been carried out on Thompson Seedless grapevines during the two consecutive seasons of 2003 and 2004 in a private vineyard at Meet Ghamr, Dakahlia Governorate.

where the soil is clayey. The vines were 30-years old, trained according to the cane-pruning system. The supporting system was a 3- wire, T- shape trellises. At winter pruning the number of buds left per vine ranged from 50 to 70 (5-6 fruit canes, each 8-10 buds in length and 3-5 renewal spurs with 2 buds on each). The vines are grown in rows 2.5 m apart and 2 m between vines in the row. Soil sample was taken from under the experimental trees before the onset of the tested treatments. The main physical and chemical properties of the soil were determined at Soil Department, Faculty of Agriculture, Zagazig University, and the results are given in Table 1.

All experimental vines received uniform practices concerning irrigation, pest and weed control as well as organic and mineral fertilization, except for the tested phosphorus fertilization treatments. Nitrogen fertilization was added as 300 kg ammonium sulfate (20.6 % N) just before the first and second irrigation in two doses (April and May in the two seasons), as well as 100 kg ammonium nitrate (33.5 % N) before the third irrigation in June. Potassium fertilization was added at the rate of 100 kg potassium sulfate (48 % K_2O) just before the first irrigation. In February, vines received 20 m^3 */fed* of organic manure with the amount of mineral phosphorus fertilization (calcium superphosphate) according to treatments. Thus, the vines received eight flood irrigations through the season.

Phosphorein was added at the amounts as illustrated in Schedule 1 before the first irrigation in a circle (in shallow trenches 10 cm depth) around each vine then covered with soil and irrigated.

Evaluated Parameters

At time of harvesting (on Aug., 20 in both seasons) the number of bunches per vine and their total weight (the yield/vine) were recorded and the average bunch weight was calculated. Samples of six bunches were taken from each replicate and the following parameters were examined: bunch length, bunch width, number of berries per bunch, bunch compactness and rachis weight. The bunch compactness was calculated according to the following equation

$$\text{Compactness} = \frac{\text{Weight of all berries on the bunch}}{\text{Length of the main and lateral axes of the rachis}}$$

In addition, samples of 100 berries each were taken from each replicate and the following physical properties were determined: weight of 100-berries (g). The berry firmness (g/cm^2) and berry attaching

Table 1. The main physical and chemical properties of the soil under experimental grapevines (December, 2002)

Physical properties	Values	Chemical properties	Values
Clay (%)	**31.95**	**Organic matter (%)**	**1.18**
Silt (%)	**56.20**	**pH**	**7.35**
Sand (%)	**11.85**	**E.C. (dsm^{-1})**	**1.26**
Texture	**Sandy clay loam**	**Available N (ppm)**	**57.3**
		Available P (ppm)	**12.91**
		Available K (ppm	**166.45**

The optimal level of NPK in soil is 0.17 % for total N, 25 ppm for P and 370 ppm for K (Sillanpaa, 1999).

Schedule 1. Different combinations between mineral phosphorus and phosphorein biofertilizer

Code No.	Phosphorus fertilizer/fed.*			Phosphorus fertilizer/vine		
	Mineral		Biofertilizer	Mineral		Biofertilizer
	Calcium superphosphate (C.P.) 15.5%(kg)	P_2O_5 (kg)	Phosphorein (Phos.) Kg	Calcium superphosphate (C.P.) 15.5 %(g)	P_2O_5 (g)	Phosphorein (Phos.) (g)
1	****100 (Cont.)**	**15.50**	**0.0**	**125.00**	**19.38**	**0.0**
2	**75**	**11.63**	**4.0**	**93.75**	**14.53**	**5.0**
3	**50**	**7.75**	**4.0**	**62.50**	**9.69**	**5.0**
4	**25**	**3.88**	**4.0**	**31.25**	**4.84**	**5.0**
5	**0.0**	**0.00**	**4.0**	**0.00**	**0.00**	**5.0**
6	**75**	**11.63**	**8.0**	**93.75**	**14.53**	**10.0**
7	**50**	**7.75**	**8.0**	**62.50**	**9.69**	**10.0**
8	**25**	**3.88**	**8.0**	**31.25**	**4.84**	**10.0**
9	**0.0**	**0.00**	**8.0**	**0.00**	**0.00**	**10.0**

***800Vines, **100 kg calcium superphosphate (C.P.) (15.5 %)/fed. is the recommended dose in the region (control).**

force (g) were determined on 10 berries per bunch using Pushpull dynamometer (Model FD101) without removing the berry peel. The berry length (cm), berry diameter (cm), and berry shape index (length/ diameter) were also determined. Moreover, the following chemical constituents of berry juice were determined: total soluble solids percentage (TSS) using a hand refractometer, total titratable acidity by titration against 0.1 sodium hydroxide in presence of phenolphethaline dye (A.O.A.C., 1980); the TSS/ acid ratio was calculated. The total, reducing and non-reducing sugars contents were determined according to Loomis and Shull (1937).

Samples of 30- mature leaves were taken from the medium location on unfruitful shoots of each replicate at harvest time (August, 20- 2003 and 2004). The leaf area was determined by Planymeter, then the fresh leaf sample was weighed. Samples were taken from fresh leaf blades to determine the contents of leaf photosynthetic pigments; i.e., chlorophyll a, chlorophyll b and carotenoids as mg/g fresh weight according to Wettestein (1957).

After wards, the blade and petiole samples of each replicate were dried at 70° C till constant dry weight and the dry weight was recorded. The blades and petioles dry samples of each replicate were finely ground and the following determinations were carried out: nitrogen (N) in leaf blades was determined according to Naguib (1969), phosphorus (P) % in leaf petioles was determined according to Kitson and Mellon (1964) and potassium (K) % in leaf petioles was determined according to Brown and Lilleland (1946).

The randomized complete block design with three replicates was followed throughout the whole experiment. The obtained date were statistically analyzed according to Snedecor and Cochran, (1982) and the New LSD methods at 5 % level was used to compare between means.

RESULTS AND DISCUSSION

The Yield and its Components

It is clear, from data in Table 2, that the yield/vine ranged from 2.84 to 4.41 kg in the first season and 5.03 to 7.87 kg in the second season and significantly varied according to the tested treatments in both seasons. However, the only significant yield reductions were by the combined treatments of (0.0 C.P. calcium superphosphate + 4 kg Phos. phosphorein/*fed*) and (0.0 kg C.P.+8 kg phos./*fed*) in the two seasons as well as by the combined treatment of (25 kg C.P. + 4 kg phos./*fed*) in the second season. Differences between all other treatments, including the control, were insignificant in the

Table 2. Effect of mineral phosphorus fertilization and phosphorein biofertilizer treatments on yield and bunch characteristics of Thompson Seedless grape (2003and 2004 seasons)

P fertilization treatments: Mineral calcium phosphate (kg/fed.)	Biological phosphorein (kg/fed.)	Yield /vine (kg)	Yield /vine ± %**	Number of bunches/ vine	Bunch weight (gm)	Bunch weight ± %**	Bunch length (cm)	Bunch width (cm)	No. of berries/ bunch	Compactness	Rachis weight (gm)
First season 2003											
100 (Cont.)	**0.0**	4.34	-	7.67	560.80	-	25.33	15.50	256.00	6.76	16.45
75	**4.0**	4.38	+0.09	7.67	570.63	+1.7	26.83	15.00	247.67	5.73	14.23
50	**4.0**	3.95	-9.00	7.67	517.13	-7.8	24.67	14.33	245.33	5.44	10.50
25	**4.0**	3.91	-10.0	7.67	513.57	-8.5	24.50	14.00	243.33	5.41	10.50
0.0	**4.0**	2.84	-34.6	7.67	372.50	-33.6	23.00	13.00	247.67	4.33	9.75
75	**8.0**	4.41	+1.60	8.00	571.83	+1.9	27.17	15.67	257.33	5.93	14.46
50	**8.0**	4.30	-1.00	8.00	551.40	-1.7	24.83	15.00	245.62	5.52	12.39
25	**8.0**	4.15	-4.40	7.67	543.57	-3.1	24.67	14.17	248.33	5.44	10.88
0.0	**8.0**	2.97	-31.60	7.67	390.00	-30.5	23.83	13.17	250.00	5.13	9.87
N.L.S.D. 0.05		1.43	-	NS	184.56	-	1.92	1.43	NS	1.71	2.78
Second season 2004											
100 (Cont.)	**0.0**	7.76	-	16.33	477.60	-	29.50	16.50	225.33	6.33	12.73
75	**4.0**	7.80	+0.50	16.33	486.53	+1.8	29.67	16.67	221.17	5.97	10.48
50	**4.0**	6.99	-10.0	16.00	435.53	-8.9	27.33	12.83	216.67	5.48	9.69
25	**4.0**	5.78	-25.6	14.00	413.33	-13.5	27.17	12.67	215.67	4.88	9.31
0.0	**4.0**	5.03	-35.2	13.00	398.33	-16.6	26.17	12.33	208.17	4.62	7.57
75	**8.0**	7.87	+1.40	16.33	489.42	+2.4	29.83	17.67	226.50	6.61	14.49
50	**8.0**	7.46	-3.90	16.33	455.93	-4.6	28.33	12.83	220.67	5.89	9.74
25	**8.0**	6.60	-15.0	14.33	436.70	-8.6	27.17	12.67	217.33	5.27	9.69
0.0	**8.0**	5.09	-34.5	13.00	404.33	-15.4	26.50	12.67	210.00	4.72	9.61
N.L.S.D. 0.05		1.37	-	NS	79.38	-	NS	2.50	NS	NS	1.24

*The control was the recommended dose 100 kg calcium monophosphate 15.5 % P_2O_5/fed. (19.4 gm P_2O_5/ vine) without adding phosphorein.
** Increase or decrease (%) in relation to control.

two seasons. The yield reductions by the treatment (0.0 kg C.P.+4 kg phos./*fed*) were -34.6 and -35.2 % in relation to the control in the two seasons. The corresponding reductions by the treatments (0.0 kg C.P.+8 kg phos./*fed*) were -31.6 and -34.5 % in the relation to control in the two seasons. From the data in Table (3), it can be recognized that only the application of 75 kg calcium superphosphate with 4 or 8 kg of phosphorein per *fed*dan showed slight increases when compared with check treatment (control) (100 kg C.P./*fed*). Thus we can say that applications of 4 or 8 kg phosphorein lowered the P needs by 25 kg C.P. as a result of its effect on solubilizing some slowly available forms of P.

The data also show that experimental vines gave 7.67-8.00 bunches/vine in the first season and 13.00-16.33 bunches/vine in the second season without any significant differences between all tested treatments in each season. So, the abovementioned differences in the yield/ vine must be due to differences in bunch weight as will be shown later.

Bunch Characteristics

Bunch weight

Table (2) shows that bunch weight ranged between 372.50-571.83g in the first season and 398.33 - 489.43 g in the second season and significantly varied according to the tested treatments in both seasons. The bunch weight followed the same trend as the yield per vine. Thus, the lightest bunches come from two treatments, i.e., (0.0 kg C.P.+4 kg phos./*fed*) which reduced bunch weight by -33.6 and -16.6 % in relation to control and (0.0 kg C.P.+8 kg phos./*fed*) which reduced the bunch weight by -30.5 and -15.4 % in relation to control in the two seasons. Differences among other treatments, within each season, were statistically insignificant.

Bunch dimensions

In the first season, the bunch length ranged 23.0-27.17 cm in comparison with the control, significant reductions in bunch length were observed with the treatments of (50 kg C.P.+4 or 8 kg phos./*fed*) , (25 kg C.P.+4 or 8 kg phos./*fed*) and (0.0 kg C.P.+4 or 8 kg phos./*fed*) as compared with the control. In the second season, however, the bunch length ranged 26.17-29.83 cm without significant differences between all treatments.

The bunch width ranged 13.0-15.5 cm in the first season and 12.33-17.67 cm in the second season with significant differences between treatments in both seasons. The treatments that significantly reduced bunch width in both seasons were: (25 kg C.P.+4 or 8 kg phos./*fed*) and (0.0 kg C.P.+4 or 8 kg phos./*fed*) as compared with the control. All other treatments recorded statistically similar values for bunch width in both seasons (Table, 2).

Number of berries/ bunch

The values ranged 243.33-257.33 in the first season and 208.17-226.50 in the second season without any significant differences between treatments in the two seasons (Table 2).

Bunch compactness

In the first season the compactness values ranged 4.33-6.76; the only significant reduction resulted from the treatment (0.0 kg C.P.+4kg phos./*fed*). In the second season, however, compactness values ranged 4.62-6.33 without any significant differences between treatments (Table 2).

Rachis weight

Rachis weight ranged between 9.87-16.45 in the first season and 7.57-14.49 in the second season. The differences between treatments were significant in both seasons. In addition, the rachis was lighter with the treatments of (50 kg C.P.+4 or 8 kg phos./*fed*), (25 kg C.P.+4 or 8 kg phos./*fed*). and (0.0 kg C.P.+4 or 8 kg phos./*fed*) than with (75 kg C.P.+4 or 8 kg phos./*fed*) and the control (Table, 2).

Berry Characteristics

Physical properties

100 berry weight

Table 3 clarifies that 100- berry weight ranged from 207.33 to 254.90 g in the first season and from 203.33 to 230.00 g in the second season. The differences between treatments were statistically significant in both seasons. However, only one treatment resulted in a significantly lower 100-berry weight in both seasons compared to control, this was (0.0 kg C.P.+4 kg phos./*fed*); the values were 207.33 and 203.33 g in the two seasons, respectively. In addition, two other treatments also significantly decreased 100-berry weight, but in the 2nd season only, those were: (25 kg C.P.+4 kg phos./*fed*) and (0.0 kg C.P.+ 8 kg phos./*fed*).

Berry dimensions

The data also show that the tested treatments significantly affected berry length, but in the second season only. In this season, shorter berries resulted from the treatments of: (25 kg C.P.+4 kg phos./*fed*) (1.67cm), (0.0kg C.P.+4 kg phos./*fed*) (1.67 cm), (25 kg C.P.+8 kg phos./*fed*) (1.70cm) and (0.0 kg C.P.+8 kg phos./*fed*) (1.67 cm). Berries of other treatments ranged 1.77-1.87 cm in length.

The berry diameter and berry shape index (length: diameter were

Table 3. Effect of mineral phosphorus fertilization and phosphorein biofertilizer treatments on physical properties of Thompson Seedless grape berries (2003and 2004 seasons)

P fertilization treatments: Mineral calcium phosphate (kg/fed.)	P fertilization treatments: Biological phosphorein (kg/fed.)	100-berry weight (g)	Berry length (cm)	Berry diameter (cm)	Berry shape index (length: diam)	Berry firmness (g)	Berry attaching force (g)
				First season 2003			
100 (Cont.)	0.0	244.67	1.87	1.43	1.31	285.00	409.00
75	4.0	247.67	1.83	1.43	1.28	285.00	362.67
50	4.0	231.27	1.83	1.40	1.31	283.33	405.00
25	4.0	219.33	1.77	1.40	1.26	290.00	350.00
0.0	4.0	207.33	1.73	1.33	1.30	275.33	348.33
75	8.0	254.90	1.87	1.43	1.31	283.33	426.00
50	8.0	238.17	1.83	1.40	1.31	278.67	350.00
25	8.0	223.93	1.80	1.33	1.35	280.00	350.33
0.0	8.0	220.33	1.77	1.37	1.29	276.00	350.00
N.L.S.D. 0.05		24.90	NS	NS	NS	NS	35.71
				Second season 2004			
100 (Cont.)	0.0	221.67	1.83	1.37	1.34	271.67	446.00
75	4.0	215.67	1.77	1.37	1.29	297.00	368.00
50	4.0	211.67	1.77	1.33	1.33	286.67	368.33
25	4.0	206.67	1.67	1.33	1.26	282.00	332.67
0.0	4.0	203.33	1.67	1.33	1.26	263.67	341.00
75	8.0	230.00	1.87	1.40	1.34	271.67	452.33
50	8.0	215.00	1.77	1.37	1.29	276.00	375.33
25	8.0	210.00	1.70	1.33	1.28	275.67	287.00
0.0	8.0	205.00	1.67	1.33	1.26	271.67	290.33
N.L.S.D. 0.05		22.09	0.13	NS	NS	NS	56.35

*The control was the recommended dose 100 kg calcium monophosphate 15.5 % P_2O_5/fed. (19.4 gm P_2O_5/ vine) without adding phosphorein.

not significantly affected by the tested treatments in both seasons (Table 3).

Berry firmness and attaching force

The berry firmness varied from 200.30 to 290.00 g/cm^2 in the first season and 263.67-297.00 g in the second season. However, the differences between tested treatments in this respect were insignificant in both seasons.

On the other hand, the berry attaching force was obviously affected by the tested treatments in both seasons. The values ranged from 348.33 to 426.00 g in the first season and 287.00-452.33 g in the second season. Only two treatments resulted in obviously higher berry attaching force in the two seasons. Those were: the control (409.00 and 446.00 g the two seasons) and (75 kg C.P.+8kg phos./*fed*) (426.00 and 452.33 g in the two seasons, respectively). The differences between those two treatments in each season were insignificant. All other tested treatments gave much lower berry attaching force in both seasons (Table 3).

Chemical constituents of the berry juice

Total soluble solids (TSS) and acidity

Table 4 reveals that juice TSS was significantly affected by the tested treatments, but only in the first season. In this season, the TSS values ranged from 19 to 23 %; the highest TSS values were recorded by the treatments: (75 kg C.P.+8 kg phos./*fed*) (23 % TSS) and (50 kg C.P.+8 kg phos./*fed*) (21.67 % TSS).

The data also show that the total acid content of the juice was significantly affected by the tested treatments in both experimental seasons. Acidity values ranged between 0.89 and 1.12 % in the first season and 0.91-1.13 % in the second season. However, no actual trend could be traced to be consistent through the two seasons.

The TSS/acid ratio ranged from 17.49 to 22.02 in the first season and 17.70-22.84 in the second season. The effect of tested treatments was significant in both seasons. However, no consistent trend could be recorded in the two seasons. In the first season, the only significant reduction was due to the treatment (0.0 kg C.P.+4 kg phos./*fed*) (17.49). In the second season, higher TSS /acid ratio resulted from the treatments: (50 kg C.P.+4 kg phos./*fed*) (22.84), (25kg C.P.+4 kg phos./*fed*) (20.56) and (0.0kg C.P.+4 kg phos./*fed*) (21.88).

Sugars contents

From Table 4, it is clear that differences between the tested

Table 4.Effect of mineral phosphorus fertilization and phosphorein biofertilizer treatments on main chemical constituents of juice of Thompson Seedless grape berries (2003 and 2004 seasons)

P fertilization treatments: Mineral calcium phosphate (kg/fed.)	P fertilization treatments: Biological phosphorein (kg/fed.)	TSS (%)	Acidity (%)	TSS/acid ratio	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)
				First season 2003			
100 (Cont.)	**0.0**	20.00	1.12	17.86	9.49	6.71	16.20
75	**4.0**	20.17	1.12	18.06	9.42	8.91	18.33
50	**4.0**	21.17	1.10	19.25	9.02	7.39	16.42
25	**4.0**	19.00	0.89	21.59	9.08	6.54	15.62
0.0	**4.0**	19.00	1.09	17.49	9.04	5.31	14.35
75	**8.0**	23.00	1.10	21.04	10.19	7.19	17.38
50	**8.0**	21.67	0.99	22.02	9.68	6.59	16.27
25	**8.0**	19.83	1.10	18.11	9.22	6.23	15.45
0.0	**8.0**	20.00	1.06	19.07	8.70	5.41	14.12
N.L.S.D. 0.05		1.84	0.16	4.40	NS	3.43	3.32
				Second season 2004			
100 (Cont.)	**0.0**	20.00	1.13	17.70	10.97	6.72	17.69
75	**4.0**	20.50	1.10	18.64	11.64	6.72	18.36
50	**4.0**	20.67	0.93	22.84	11.37	6.81	18.18
25	**4.0**	20.00	0.99	20.56	10.43	6.69	17.12
0.0	**4.0**	19.67	0.91	21.88	10.50	6.83	17.33
75	**8.0**	20.33	1.12	18.16	11.58	7.20	18.78
50	**8.0**	20.17	1.09	18.57	12.30	6.38	18.67
25	**8.0**	20.00	1.13	17.70	11.78	6.46	18.24
0.0	**8.0**	20.00	1.11	18.03	10.52	6.45	16.97
N.L.S.D. 0.05		NS	0.20	4.18	1.47	NS	1.46

*The control was the recommended dose 100 kg calcium monophosphate 15.5 % P_2O_5/fed. (19.4 gm P_2O_5/ vine) without adding phosphorein.

treatments in reducing and non-reducing sugars contents were significant in only one of the two considered seasons. Reducing sugars revealed significant differences in the second season only when the treatments of (0.0 kg C.P.+4kg phos./*fed*),(25 kg C.P.+4 kg phos./*fed*) and (0.0 kg C.P.+8 kg phos./*fed*) indicated lower reducing sugars contents than other tested treatments. Non-reducing sugars content indicated significant differences between treatments only in the first season, when the treatments of (0.0 kg C.P.+4 kg phos./*fed*) and (0.0 kg C.P.+8 kg phos./*fed*) were lower in their non-reducing sugars content. However, the juice total sugars content revealed significant differences between the tested treatments in both seasons. The values, generally, ranged 14.12 and 18.33 % in the first season and 16.97-18.78 % in the second season. In both seasons, the three treatments of : (0.0 kg C.P.+4 kg phos./*fed*), (25kg C.P.+4 kg phos./ *fed*) and (0.0 kg C.P.+8 kg phos./ *fed*) recorded the lowermost values of juice total sugars content. The values were: 14.35, 15.62 and 14.12 % against 16.20 % for the control in the first season and 17.33, 17.12 and 16.97 % against 17.69 % for the control in the second season for the three abovementioned treatments in a respective order.

Leaf Characteristics

Leaf area and leaf fresh and dry weights

As shown in Table 5 the leaf area was significantly affected by the tested treatments in both seasons. The values varied between 53.00 and 66.67 cm^2 in the first season and 56.4-77.82 cm^2 in the second season. The treatments that recorded significantly lower leaf area compared to the control in both seasons were: (0.0 kg C.P.+8kg phos./*fed*) which recorded 58.0 and 58.42 cm^2 in the two seasons and (25 kg C.P.+8 kg phos./*fed*) which recorded 60.67 and 56.40 cm^2 in the two seasons. The differences between those two treatments were insignificant in both seasons. In addition, smaller leaves also resulted from the treatments of: (0.0 kg C.P.+4 kg phos./*fed*), (25 kg C.P.+4kg phos / *fed*) and (50kg C.P.+4 kg phos./ *fed*), but this was observed in the first season only.

As for leaf weight, the data show insignificant differences between the tested treatments concerning leaf dry weight in both seasons and leaf fresh weight in the first season. However, the leaf fresh weight revealed significant differences between treatments in the second season only when the treatments of: (0.0 kg C.P.+ 4 or 8 kg phos./*fed*) and (25 kg C.P.+ 4 or 8 kg phos. / *fed*) gave lighter fresh leaves as compared to the control.

Table 5.Effect of mineral phosphorus fertilization and phosphorein biofertilizer treatments on leaf characteristics, photosynthetic pigments and mineral contents in leaves of Thompson Seedless grape (2003 and 2004 seasons)

P fertilization treatments: Mineral calcium phosphate (kg/fed.)	P fertilization treatments: Biological phosphorein (kg/fed.)	Leaf area (cm^2)	Leaf fresh weight (g)	Leaf dry weight (g)	Chlorophyll (mg/g F.W.): a	Chlorophyll (mg/g F.W.): b	Chlorophyll (mg/g F.W.): Total (a+b)	Carotenoides (mg/g F.W.)	Leaf mineral contents: N % in blade	Leaf mineral contents: P % in petiole	Leaf mineral contents: K % in petiole
					First season 2003						
100 (Cont.)	**0.0**	62.67	2.64	0.73	1.41	0.85	2.26	0.51	1.50	0.172	1.13
75	**4.0**	62.67	2.64	0.74	1.59	0.77	2.36	0.53	1.29	0.174	1.13
50	**4.0**	61.17	2.63	0.68	1.08	0.71	1.79	0.43	1.20	0.165	1.06
25	**4.0**	57.17	2.62	0.68	0.84	0.77	1.61	0.34	1.17	0.165	0.82
0.0	**4.0**	53.00	2.52	0.67	0.82	0.83	1.65	0.36	1.21	0.168	1.05
75	**8.0**	66.67	2.68	0.76	1.93	0.71	2.64	0.50	1.54	0.178	1.14
50	**8.0**	65.83	2.58	0.68	1.20	0.85	2.05	0.54	1.10	0.171	1.09
25	**8.0**	60.67	2.58	0.67	0.79	0.85	1.65	0.56	1.22	0.169	0.83
0.0	**8.0**	58.00	2.55	0.67	0.90	0.81	1.70	0.39	1.18	0.164	1.00
N.L.S.D. 0.05		4.66	NS	NS	0.57	NS	0.53	0.17	0.32	NS	0.10
					Second season 2004						
100 (Cont.)	**0.0**	68.00	4.20	0.80	1.45	1.99	3.44	0.78	1.30	0.167	1.00
75	**4.0**	69.42	4.83	0.82	1.21	1.09	2.30	0.76	1.22	0.176	0.98
50	**4.0**	66.87	4.82	0.80	1.17	1.45	2.62	0.82	1.11	0.171	0.90
25	**4.0**	66.86	3.86	0.75	1.24	1.95	3.19	0.71	1.08	0.169	0.89
0.0	**4.0**	62.66	3.86	0.69	1.25	1.10	2.35	0.71	1.05	0.167	0.92
75	**8.0**	77.82	4.46	0.81	1.26	1.25	2.51	0.83	1.34	0.183	1.01
50	**8.0**	69.07	4.43	0.76	1.23	1.53	2.76	0.80	1.17	0.182	0.93
25	**8.0**	56.40	3.48	0.65	1.17	1.18	2.35	0.76	1.02	0.179	0.90
0.0	**8.0**	58.42	3.49	0.72	0.97	0.97	1.94	0.72	1.05	0.170	0.90
N.L.S.D. 0.05		17.74	0.76	NS	0.40	0.82	0.62	NS	0.18	NS	NS

*The control was the recommended dose 100 kg calcium monophosphate 15.5 % P_2O_5/fed. (19.4 gm P_2O_5/ vine) without adding phosphorein

Leaf photosynthetic pigments contents

From Table 5 it could be, generally, observed that total chlorophyll content in the leaf blade was lower in all tested combinations between calcium superphosphate and phosphorein as compared with the combination of (75 kg C.P.+ 4 or 8 kg phos./*fed*) in the first season. However, the reductions were statistically significant in the second season only with the combination of (75 kg C.P.+4 or 8 kg phos./*fed*), while was significant in both seasons with other combinations. In addition, the leaf carotenoids content was significantly decreased by the combinations of: (25 kg C.P.+4kg phos./*fed*),(0.0kg C.P.+4 kg phos./*fed*) and (0.0 kg C.P.+8 kg phos./*fed*)as compared to the control, but this was in the first season only.

Leaf N, P and K contents

As shown in Table 5, the combinations of: (0.0 and 25kg C.P./*fed*) with both rates of phosphorein (i.e., 4 and 8 kg /*fed*) depressed N content in leaf blade and both P and K contents in leaf petioles as compared with the control. However, the reductions in P content did not reach the level of significance in both seasons, while the reductions in K level was significant in the first season only.

Generally, the obtained results reveal that in comparison with the control (i.e. 100 kg/*fed* calcium superphosphate 15.5 %), it is clear that depression was observed in the fruiting and growth activities of Thompson Seedless grapevines under the two lowermost rates of calcium superphosphate (0.0 and 25 kg/*fed*) despite of adding 4 or 8 kg phosphorein/*fed* This was clear in the two seasons of investigation, which means that both tested rates of phosphorein (4 and 8 kg/*fed*) failed to compensate the severe reductions in the rate of calcium phosphate. This might be due to the key role of phosphorus in the conservation and transfer of energy for a wide range of biochemical processes. Thus, phosphorus is essential for cell division and for the development of meristem tissues. For example, cereals suffering from phosphorus deficiency have a stunted root system, stem and leaves (Wild, 1988). Also, Mengel and Kirkby (1978) observed that when P deficiency was severe the contents of phospholipids and RNA were markedly depressed and the growth stopped. The reduction in synthesis of RNA as a result of inadequate P supply has an impact on protein synthesis, and consequently on vegetative growth. Fruit trees show reduced growth rates of new shoots and frequently the development and opening of buds is unsatisfactory. The formation of fruits and seeds is especially depressed in plants suffering from P deficiency. Thus not only low yields but also poor quality fruits and seeds are obtained from P deficient crops.

On the other hand, the medium rates of calcium superphosphate (i.e., 75 and 50 kg /*fed*) in combination with the biofertilizer phosphorein (4 or 8 kg /*fed*) were nearly as efficient as the control (100 kg calcium superphosphate /*fed*) regarding most of the studied parameters. However, as fertilization experiments usually need extended work over many years, it could be suggested to continue the evaluation of the combinations between the medium levels of calcium superphosphate (i.e., 75 and 50 kg/*fed*) and the two rates of phosphorein (4 and 8 kg/ *fed*) for a longer period.

Previous literature reports on phosphorus biofertilization of fruit trees are few. The used in this respect microorganisms included the mycorrhizal fungus (*Glomus fasiculatum*, and the bacteria *Bacillus megatherium*. The use of such phosphate solubilizing micro-organisms increased the number of bunches, bunch weight and the yield as well as berry weight and juice TSS, while reduced juice acidity of Red Roomy grape (Ahmed *et al.*, 1997 and Akl *et al.*, 1997). Analogical results were obtained on Anna apple trees by Mansour (1998). In addition, soil inoculation mycorrhizal fugues (VAM) increased the area and chlorophyll content of apple seedlings (Sharma and Bhutani, 1998) and peach seedlings (Mahmoud and Mahmoud, 1999). Also, inoculation with *Bacillus sp.* and mycorrhiza increased the yield, fruit weight and juice TSS of custard apple (Balakrishnan *et al.*, 2001).

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استخدام السماد الحيوى فوسفورين لخفض معدل التسميد الفوسفاتى المعدنى فى بستان العنب صنف تومسون سيدلس

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فى تجربة حقلية خلال موسمى عامى ٢٠٠٣ و ٢٠٠٤ تم تسميد كروم بالغة من العنب صنف تومسون سيدلس (البناتى) النامية فى ارض طميية طينية رملية تروى بالغمر بالمعدل المعتاد من سماد سوبر فوسفات الكالسيوم (١٥,٥ % فو٢أ٥) وهى ١٠٠ كجم/ فدان وكانت هذه هى معاملة المقارنة (كنترول) كما تلقت كروم أخرى كميات أقل من سوبر فوسفات الكالسيوم (٧٥،٥٠،٢٥، صفر كجم/فدان) مع إضافة السماد الحيوى فوسفورين بكمية ٤ أو ٨ كجم/ فدان لكل منها، وتم تقييم تأثير المعاملات التسعة المختبرة من خلال دراسة مكونات المحصول ، وصفات العناقيد ، والصفات الطبيعية للثمار، والمكونات الكيماوية الرئيسية للعصير وأيضا مساحة ووزن الورقة ومحتواها من الصبغات ومن عناصر النيتروجين والفوسفور والبوتاسيوم وأظهرت النتائج تأثيرا سلبيا للمعاملات التى احتوت على صفر أو ٢٥ كجم فوسفات الكالسيوم/فدان مضافا اليها ٤ أو ٨ كجم فوسفورين/فدان وذلك على كثير من أنشطة الكرمة مقارنة بالكروم التى تلقت ١٠٠ كجم سوبر فوسفات الكالسيوم/فدان فقط، وظهر هذا التأثير السلبى مبكرا أي فى الموسم الأول والثانى من المعاملة وأوضح هذا ان المعدلين المختبرين من الفوسفورين (٤،٨ كجم/فدان) لم يعوضا عدم إضافة سماد فوسفات الكالسيوم أو إضافته بمعدل منخفض (٢٥ كجم/ فدان). ولكن النتائج أظهرت أن المعدلاست المتوسطة من فوسفات الكالسيوم (٧٥ ، ٥٠ كجم/ فدان) مع إضافة الفوسفورين بمعدل ٤ أو ٨ كجم/فدان أعطت نتائج قريبة من الكنترول (١٠٠ كجم سوبر فوسفات الكالسيوم/ فدان) بالنسبة لمعظم الصفات تحت الدراسة . آي أنها وفرت ما يساوى ٢٥ او ٥٠ كجم سوبر فوسفات الكالسيوم.

ونظرا لضرورة استمرار تجارب التسميد لاعوام كثيرة ، فانه يمكن اقتراح استمرار تقييم المعاملات المشتركة بين المعدلات المتوسطة لفوسفات الكالسيوم (٧٥ ، ٥٠ كجم/ فدان) مع إضافة الفوسفورين بمعدل ٤ ، ٨ كجم لكل منها حتى يمكن اعتبار هذه التوصيات فعالة ونهائية.