Effect of Yeast and Different Phosphorus Fertilizer Sources on Growth and Fruiting of Balady Mandarin Trees.

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Abstract:

This investigation was carried out in the experimental orchard, Faculty of Agriculture, Assiut University, Egypt, to study the effect of soil inoculation with yeast or phosphorin (P- dissolved bacteria) only or combined with 50 or 25% mineral-P on growth and fruiting of Balady mandarin trees during 2011, 2012 and 2013 seasons. Calcium superphosphate was applied once in December. Yeast and phosphorin were applied once in March followed by the trees were irrigated.

The obtained results were summarize as follow:

- Using yeast or phosphorin as bio-fertilizers only or combined with 50 or 25% of the recommended phosphorus dose (RPD) significantly increased the shoot and leaf traits.

- Leaf content of chlorophyll and nutrient elements as well as the total carbohydrates and C/N ratio of shoots were significantly increased due to use of either yeast or phosphorin singly or combined with phosphours at 50 or 25% of RPD compared to use the RPD via mineral-P source alone (check treatment).

- Yield components and fruit quality was significantly improved due to use of either yeast or phosphorin, singly or combined with either 25 or 50% of RPD compared to use mineral-P only.

Using yeast or phosphorin only or combined with 25% mineral-P was very effective in improving the growth and fruiting of the trees.

Moreover, using yeast was superior in improving the yield and fruit quality than using phosphorin, where, using yeast at 200 ml/tree gave the best results.

It is evident from the foregoing results that using yeast either 200 ml/tree only or yeast at 150 ml plus 25% of RPD as mineral-P as well as phosphorin either 400 ml/tree only or phosphorin at 300 ml with 25% of RPD as mineral-P improve the superphosphate use efficiency through increasing the P availability and consequently, decreasing the amount of applied phosphatic fertilizer and reducing both the agriculture cost and the pollution impact of superphosphate.

Keywords: Bio-fertilization, Balady mandarin, nutrient status, yield, fruit quality.

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Introduction:

Citrus is an important cash crops and an essential source of vitamin C for human diet. It's native tree of tropical and sub-tropical regions. Citrus trees have an outstanding economical importance among fruit crops in Egypt. Mandarin occupies the second planted citrus species after orange. Because of the importance of citrus production in Egypt, it is natural for the citrus growers to be mindful of the factors which may positively influence the productivity such as bio-fertilization and application of compounds containing K and P nutrients. Phosphorus is an essential nutrient and it plays an important role in the biosynthesis and translocation of carbohydrates and its necessary in stimulating cell division and the formation of DNA and RNA (Nijjar, 1985). Also, it is very important in the metabolic processes, i.e. blooming and flower development. It is the main constituent of energy compounds (ATP and ADP) Kurtsidze (1984). Soils contain about 0.05% (W/W) of phosphorus and plant use about 0.1% of this phosphorus (Scheffer and Schachtschabel, 1992).

In the development and implementation of sustainable agriculture techniques, bio-fertilization is of great importance in order to alleviate deterioration of natural and environmental pollution. Bio-fertilizers are microbial preparations containing living of different microorganisms which have the ability to mobilize plant nutrients in soil from unusable to usable form through biological process (Subba Rao, 1984). Bio-fertilizers are able to fix atmospheric nitrogen, solubilize P & K and mobilize P, Zn, Fe, Mo to varying extent. They play a very significant role in improving soil fertility help host plants to resist diseases and withstand stress conditions (Hazarika and Ansari, 2007). Bio-fertilizers could improve crop productivity through increasing biological N-fixation, availability and uptake of nutrients as well as stimulation of natural hormones (Kannaiyan, 2002; Abdel-Moniem *et al*., 2003; Hegab *et al*., 2005 and El-Salhy *et al*., 2006).

Biological P fertilization through using PSB plays an important role in increasing yield and fruit quality and decreasing chemical phosphorus fertilizer requirements (Hauka *et al*., 1990 and Attia *et al*., 2002). Many studies have shown that a wide of microorganisms can solubilize phosphate (Gaind and Gaur, 1991; Ibrahim *et al*., 1995). Others indicated that soils inoculated with P-solubilizing microorganisms improved soil fertility and plant productivity through releasing P from rock or tricalcium phosphate and bio-fertilizer (Ragab, 1999; Attia *et al*., 2002; Hegab *et al*., 2005; Mostafa, 2006; Ismail-Omayma *et al*., 2011 and El-Khayat and Abdel-Rehiem, 2013). As well as the role of phosphorus on improving growth, nutritional status of trees, yield and fruit quality of citrus fruits was reviewed by Franciosi *et al*. (1985), El-Dawwey and Ahmed (1991), Farahat (2000). Therefore, it is essential to adopt a strategy of integrated nutrient supply by using a judicious combination of chemical fertilizer and bio-fertilizer of microbial origin.

So, the present study aimed to investigate the effect of inoculation with yeast or phosphate dissolving bacteria on growth and fruiting of Balady mandarin trees.

Materials and Methods:

The present study was carried out during three successive seasons of 2011, 2012 and 2013 on 17 years old Balady mandarin trees budded on sour orange root stock and planted at 5x5 m apart. They, grown on the Experimental Orchard of the Faculty of Agriculture, Assiut University, Egypt, where the soil has a clay texture (Table 1) and irrigated via surface irrigation and it is well drained.

Table (1): Analysis of the soil of the experimental site before starting the study.

Characters		Character	
Sand (%)	21.15	Total N (%)	0.14
Silt (%)	31.55	Available P (ppm)	8.25
Clay (%)	48.30	Available K (ppm)	332.15
Texture	Clay	DTPA-extractable	
pH (1:2.5)	8.19	Fe (ppm)	22.70
E.C (1:2.5) (dS/m)	2.26	Mn (ppm)	18.31
Organic matter (%)	1.38	Zn (ppm)	4.6
$CaCO_3$ (%)	3.66		

Twenty seven healthy trees with no visual nutrient deficiency symptoms and were as uniform as possible were chosen and asigned for carrying out this experiment. The chosen trees were divided into nine groups. Each group contained three trees (replicates) and received one fertilization regime management as the following.

- T1- 100 ml yeast culture (*Saccharomyces erigans*)/tree.
- T2- 100 ml yeast culture + (50% of RPD) 600 g calcium super phosphate (15.5% P_2O_5)/tree.
- T3- 150 ml yeast culture + (25% of RPD) 300 g calcium super phosphate/tree.
- T4- 200 ml yeast culture/tree.
- T5- 200 ml phosphorin (p-dissolved bacteria)/tree.
- T6- 200 ml phosphorin + (50% of RPD) 600 g calcium super phosphate/tree.
- T7- 300 ml phosphorin + (25% of RPD) 300 g calcium super phosphate/tree.
- T8- 400 ml phosphorin/tree.
- T9- Applying the recommended phosphorus dose (RPD), 1200 g calcium super phosphate/tree.

Treatments were arranged in a randomized complete block design with three replicates per treatment, one tree each. Calcium super phosphate was applied once in December. Yeast and phosphorin as biofertilizers were applied once in March and then the trees wee directly irrigated. Other horticulture practices were carried out as usual.

The following parameters were measured during the three growth seasons.

A- Vegetative growth and nutrient status:

Four main branches which were nearly uniform in growth, diameter and foliage density and distribution around the periphery from each tree were chosen and labeled in February. In the autumn growth cycle, the following vegetative characters were measured status were measured:

1- Shoot length (cm).

2- Leaf number/shoot.

3- Leaf area (cm^2), was estimated by bicking and weighing 30 full mature leaves/tree and the weighing of 60 sections of 1 cm^2 (2 sections of 1 cm^2/leaf) were recorded, then the average leaf area (cm^2) = leaves weight (g) x 2/sections weight (g)

4- Leaf chlorophyll content was recorded by using chlorophyll meter (SPAD 502 plus). Using four leaves/replicate from the fourth terminal expended leaf of the shoot.

5- Nutrient status.

To determine the leaf nutrient content, fifty mature leaves of a seven months age from the non fruiting shoots of the Spring flush were randomly taken from each replication in mid September. As well as to determine the shoot total carbohydrates and nitrogen, twenty non fruiting shoots with seven months age of the Spring flush were taken at random from each replication. The leaf samples were washed with tap water and distilled water. Then both leaf and shoot samples were air-dried, oven-dried at 70°C to a constant weight, ground in a stainless steel mill and kept for chemical analysis (Nijjar, 1985). One part of each ground sample was analyzed for total nitrogen by the semi-microkjeldahl technique (Bremner and Mulvaney, 1982 and Wilde *et al*., 1985). Another part of each ground dried leaf sample was wet-digested with concentrated sulfuric acid and 30% hydrogen peroxide according to the method described by Evenhuis and Dewaard (1980). Phosphorus and potassium in the digest were determined by colorimetric and flame photometry methods respectively (Jackson, 1958). Iron, Zn, Mn and Cu in the digests were estimated by using a shimadza model AA 63002 atomic absorption/flame emission spectrophotometer. Other part of each ground shoot sample used to determine the total carbohydrates according to Smith *et al*. (1956).

B- Yield and its components:

Ten distributed fruiting shoots around trees were chosen and labeled before the beginning of treatments. The flowers per each shoot were recorded. Before harvest, the fruit retention for each branch was calculated as:

$$\text{Fruit retention } (\%) = \frac{\text{Total fruits number}}{\text{Total flower numnrt}}$$

At harvesting time, in the last week of December, the number of fruit per tree was counted and then, the yield per tree was calculated.

C- Fruit Quality:

Samples of 10 fruits were randomly taken from each tree to estimate the fruit quality. The fruit weight and the chemical fruit quality such as total soluble solids, total acidity, ascorbic acid and sugar contents were determined according to A.O.A.C. methods (1985). The obtained data were statistically analyzed according to Gomez and Gomez (1984) and Mead *et al*. (1993) the L.S.D. test was used to define the significant of the differences among the various treatment means.

Results:

1- Growth and nutrient status:

Tables (2, 3 & 4) show the effect of inoculating the soil with yeast or phosphorin alone or in combination with applying mineral P at 50 or 25% of the recommended phosphorus dose (RPD) on vegetative growth and nutrient status of Balady mandarin trees during 2011, 2012 and 2013 seasons. It is obvious from the data that the results took similar trend during the three studies seasons.

In general view, shoot length, leaf number/shoot and the leaf area as well as content of chlorophyll, macronutrient (N, P & K) and micronutrient (Fe, Mn, & Zn) were significantly increased by using of either yeast at 100 or 200 ml as well as phosphorin at 200 or 400 ml/tree single or combined application of phosphorus at 50 or 25% of RPD plus either yeast at 100 or 150 ml as well as phosphorin at 200 or 300 ml/tree (all treatments) compared to use the RPD via mineral-P source alone (check treatment). The increment was associated with increasing yeast or phosphorin concentrations. Application of yeast only or combined was favorable to stimulate the growth and nutrient status rather than using phosphorin either alone or combination with mineral-P. The maximum values of these traits were detected on the trees treated with 200 ml yeast. No significant differences were found in these traits due to use yeast either 200 ml or combined yeast at 150 ml with 25% of recommended phosphorus dose via mineral-P. On other hand, the minimum values were recorded on trees treated with RPD via mineral-P alone. Furthermore using yeast resulted in more announced and high significant increment in leaf phosphorus content compared to use phosphorin.

Hence, using yeast or phosphorin as bio-fertilization only or combined with 25% mineral-P was very effective in improving the growth and nutritional status of trees. In addition avoiding P deficiency in the trees and P fixation in the soil and it decreases the cost of production and environmental pollution problems.

2- Shoot total carbohydrates and nitrogen percentage and C/N ratio:

Data illustrated in Table (5) show that applying the Balady mandarin trees with yeast or phosphorin either singly or combined with either 25 or 50% out of RPD significantly increased total carbohydrates and nitrogen percentage of shoot compared to treatment (control). Moreover, the increasing in total carbohydrates was more rather than the increasing of total nitrogen percentage, hence the C/N ratio was significantly increased compared with the check ones. The highest value of these traits (1.09% Total N, 10.82% Total C & 9.93 C/N ratio) were obtained by using yeast at 200 ml/tree followed descendingly by yeast 150 ml plus 25% P and 100 ml plus 50% P/tree respectively. No significant difference was noticed among yeast at 200 ml or 150 ml plus 25% P/tree. Also, there was no significant difference for C/N ratio due to use phosphorin at 400 ml or yeast either 100 ml plus 50% P or 150 ml plus 25% P. Such results might be due to better supply of food material and carbohydrates that are manufactured in leaves. These findings emphasized the fact that the growth vigor and fruiting depended on food material carbohydrates that are manufactured in leaves and reserved amount in tissues as well as nutritional status of trees that improving due to yeast or phosphorin application as a bio-fertilization comparing with 100% mineral-P only (superphosphate).

3- Yield and its components:

Data in Table (6) indicated that the fruit retention percentage and number of fruit per tree were significantly increased due to use either yeast or phosphorin whatever singly or combined with either 25 or 50% out of RPD compared to use the recommended dose completely via mineral-P source only. Hence, the yield significantly increased due to these treatments compared to check treatment.

The increment of these traits was associated with increasing the concentrations of yeast or phosphorin. Using any yeast treatment either singly or combined with mineral-P was preferable in increasing the yield components than using phosphorin either only or combination. No significant differences were found in the yield components with using the yeast either at 200 ml/tree or combined yeast at 150 ml with 25% of RPD via mineral-P as well as phosphorin either 400 ml only or combined phosphorin at 300 ml with 25% of RPD via mineral-P (calcium superphosphate).

Table (2): Effect of different phosphorus fertilization sources on some vegetative growth of Balady mandarin trees during 2011, 2012 and 2013 seasons.

Characters / Treat.	Shoot length (cm)				Leaves number/shoot				Leaf area (cm^2)				Chlorophyll (%)			
Season	2011	2012	2013	Mean	2011	2012	2013	Mean	2011	2012	2013	Mean	2011	2012	2013	Mean
100 ml yeast	38.57	41.33	52.33	44.08	38.60	36.00	45.55	40.05	7.78	8.57	10.30	8.88	42.67	48.32	58.33	49.77
100 ml yeast + 50% P (600 g SP)	43.07	43.23	54.67	46.99	45.90	53.67	54.51	51.36	8.98	9.27	12.87	10.37	58.00	64.87	71.80	64.89
150 ml yeast + 25% P (300 g SP)	43.67	44.07	55.00	47.58	54.13	64.60	66.25	61.66	9.28	10.25	13.27	10.93	61.33	65.80	76.30	67.81
200 ml Yeast	44.67	44.80	56.67	48.71	57.17	66.43	68.80	64.10	9.77	10.30	13.70	11.26	68.33	71.10	77.00	72.14
200 ml Phosphorin	37.67	41.03	51.67	43.46	36.00	34.53	43.20	37.91	7.67	8.15	10.30	8.71	38.33	42.68	50.20	43.74
200 ml Pho. + 50% P (600 g SP)	40.37	41.37	52.67	44.80	38.57	36.13	47.10	40.60	8.41	8.17	11.10	9.23	42.67	48.70	59.03	50.13
300 ml Pho. + 25% P (300 g SP)	42.47	42.00	53.00	45.82	42.80	41.67	50.41	44.96	8.70	9.27	11.43	9.80	52.33	56.33	66.17	58.28
400 ml Phosphorin	42.67	42.47	54.33	46.49	44.00	42.67	49.80	45.49	8.67	9.27	11.47	9.80	52.33	59.05	66.30	59.23
Control (1200 g SP)	34.37	38.17	48.35	40.29	29.17	28.20	31.80	29.72	6.78	7.06	9.13	7.66	37.33	41.47	48.77	42.52
LS.D. 5%	3.15	2.67	3.05	2.95	3.29	2.12	3.03	2.81	0.68	0.89	0.94	0.84	3.07	3.89	3.65	3.54

Table (3): Effect of different phosphorus fertilization sources on leaf N, P and K of Balady mandarin trees during 2011, 2012 and 2013 seasons.

Characters / Treat.	N%				P%				K%			
Season	2011	2012	2013	Mean	2011	2012	2013	Mean	2011	2012	2013	Mean
100 ml yeast	2.29	2.22	2.32	2.28	0.40	0.36	0.39	0.38	1.63	1.81	1.81	1.75
100 ml yeast + 50% P (600 g SP)	2.51	2.37	2.42	2.43	0.44	0.42	0.40	0.42	1.92	1.96	1.90	1.93
150 ml yeast + 25% P (300 g SP)	2.58	2.46	2.47	2.50	0.46	0.44	0.44	0.45	2.04	2.04	2.03	2.04
200 ml Yeast	2.63	2.51	2.48	2.54	0.47	0.45	0.46	0.46	2.10	2.06	2.07	2.08
200 ml Phosphorin	2.28	2.21	2.30	2.26	0.36	0.32	0.34	0.34	1.57	1.77	1.68	1.67
200 ml Pho. + 50% P (600 g SP)	2.31	2.22	2.33	2.29	0.40	0.36	0.35	0.37	1.61	1.73	1.69	1.70
300 ml Pho. + 25% P (300 g SP)	2.41	2.26	0.40	2.36	0.41	0.36	0.39	0.39	1.83	1.89	1.81	1.84
400 ml Phosphorin	2.44	2.36	2.43	2.41	0.41	0.38	0.40	0.40	1.89	1.94	1.87	1.90
Control (1200 g SP)	2.15	2.05	2.17	2.12	0.29	0.27	0.27	0.28	1.44	1.59	1.56	1.53
LS.D. 5%	0.12	0.14	0.09	0.12	0.03	0.04	0.04	0.04	0.09	0.07	0.08	0.08

Table (4): Effect of different phosphorus fertilization sources on leaf Fe, Mn and Zn of Balady mandarin trees during 2011, 2012 and 2013 seasons.

Characters / Treat.	Fe (ppm)				Mn (ppm)				Zn (ppm)			
Season	2011	2012	2013	Mean	2011	2012	2013	Mean	2011	2012	2013	Mean
100 ml yeast	125.25	132.58	127.41	128.41	27.61	34.12	28.85	30.19	36.96	41.96	38.95	39.29
100 ml yeast + 50% P (600 g SP)	132.00	142.80	134.90	136.57	28.10	35.30	29.73	31.04	42.73	48.81	43.87	45.14
150 ml yeast + 25% P (300 g SP)	140.75	152.73	93.99	129.16	31.12	35.11	32.50	32.91	50.53	57.35	51.94	53.27
200 ml Yeast	157.75	170.71	161.23	163.23	34.61	40.18	35.18	36.66	54.71	61.41	56.16	57.43
200 ml Phosphorin	120.50	132.53	124.28	125.77	25.50	32.50	27.18	28.39	38.21	44.18	39.29	40.56
200 ml Pho. + 50% P (600 g SP)	134.50	146.73	137.86	139.69	26.70	33.31	28.12	29.38	41.89	48.13	43.11	44.38
300 ml Pho. + 25% P (300 g SP)	146.25	159.28	149.54	151.69	26.50	32.85	27.69	29.01	43.11	50.52	44.60	46.08
400 ml Phosphorin	164.00	142.05	166.03	157.36	31.12	38.25	32.69	34.02	46.50	53.27	47.59	49.12
Control (1200 g SP)	110.30	117.28	112.18	113.25	17.25	21.18	18.22	18.88	24.80	31.95	27.36	28.04
LS.D. 5%	7.36	7.89	7.64	7.63	1.98	2.42	2.08	2.16	2.59	3.23	2.73	2.85

Table (5): Effect of different phosphorus fertilization sources on shoot C, N and C/N ratio of Balady mandarin trees during 2011, 2012 and 2013 seasons.

Characters / Treat.	Shoot total nitrogen %				Total shoot carbohydrates %				C/N ratio			
Season	2011	2012	2013	Mean	2011	2012	2013	Mean	2011	2012	2013	Mean
100 ml yeast	0.95	1.01	0.97	0.98	8.94	8.80	9.20	8.98	9.41	8.71	9.48	9.20
100 ml yeast + 50% P (600 g SP)	1.03	1.08	1.01	1.04	10.00	9.92	10.40	10.11	9.71	9.10	10.30	9.70
150 ml yeast + 25% P (300 g SP)	1.06	1.10	1.05	1.07	10.43	10.50	10.72	10.55	9.84	9.54	10.21	9.86
200 ml Yeast	1.08	1.13	1.06	1.09	10.76	10.80	10.88	10.82	9.96	9.57	10.26	9.93
200 ml Phosphorin	0.94	1.01	0.97	0.97	8.18	8.11	8.45	8.25	8.70	8.02	8.71	8.48
200 ml Pho. + 50% P (600 g SP)	0.94	1.01	0.98	0.98	8.33	8.24	8.56	8.38	8.86	8.15	8.73	8.58
300 ml Pho. + 25% P (300 g SP)	0.95	1.02	1.00	0.99	8.65	8.86	9.18	8.90	9.11	8.69	9.18	9.99
400 ml Phosphorin	1.00	1.06	1.01	1.02	9.74	9.68	10.16	9.86	9.74	9.13	10.05	9.64
Control (1200 g SP)	0.91	0.95	0.93	0.93	7.18	7.21	7.39	7.26	7.89	7.59	7.94	7.81
LS.D. 5%	0.03	0.05	0.04	0.04	0.28	0.31	0.25	0.28	0.30	0.26	0.25	0.27

Table (6): Effect of different phosphorus fertilization sources on the yield and its components of Balady mandarin trees during 2011, 2012 and 2013 seasons.

Treat. \ Characters	Fruit retention %				Number of fruit/tree				Yield/tree (kg)			
Season	2011	2012	2013	Mean	2011	2012	2013	Mean	2011	2012	2013	Mean
100 ml yeast	1.72	1.89	2.09	1.90	246.00	368.00	352.00	322.00	37.61	53.80	59.10	50.17
100 ml yeast + 50% P (600 g SP)	1.86	2.08	2.11	2.02	255.67	425.00	392.67	357.78	41.80	64.62	69.25	58.56
150 ml yeast + 25% P (300 g SP)	1.95	2.17	2.14	2.09	259.00	434.33	392.67	362.00	43.55	70.86	73.00	62.47
200 ml Yeast	1.95	2.18	2.17	2.10	260.00	437.00	394.67	363.89	44.38	71.30	73.86	63.18
200 ml Phosphorin	1.54	1.75	1.97	1.75	236.00	350.10	332.67	306.26	38.87	50.18	54.20	47.75
200 ml Pho. + 50% P (600 g SP)	1.58	1.78	2.01	1.79	236.00	351.67	332.67	307.05	35.89	51.95	56.58	48.14
300 ml Pho. + 25% P (300 g SP)	1.64	1.88	2.03	1.85	235.00	362.80	342.33	313.48	36.68	54.20	59.24	50.04
400 ml Phosphorin	1.66	1.90	2.05	1.87	241.33	365.00	342.33	316.22	37.54	55.21	59.40	50.72
Control (1200 g SP)	1.35	1.53	1.78	1.55	222.40	331.67	313.67	288.91	32.88	46.48	50.83	43.40
LS.D. 5%	0.17	0.21	0.16	0.18	9.98	14.49	12.55	12.34	1.80	2.11	2.39	2.10

Table (7): Effect of different phosphorus fertilization sources on fruit weight, total soluble solids (TSS) of Balady mandarin fruits during 2011, 2012 and 2013 seasons.

Treat. \ Characters	Fruit weight (gm)				T.S.S. %				Acidity %			
Season	2011	2012	2013	Mean	2011	2012	2013	Mean	2011	2012	2013	Mean
100 ml yeast	153.23	146.67	168.00	155.97	12.00	12.33	12.67	12.33	1.08	1.13	1.18	1.13
100 ml yeast + 50% P (600 g SP)	163.67	152.33	176.67	164.23	12.33	12.67	13.00	12.67	1.02	1.07	1.13	1.07
150 ml yeast + 25% P (300 g SP)	168.23	162.67	187.00	172.63	12.33	12.70	13.33	12.79	1.00	1.02	1.06	1.03
200 ml Yeast	170.57	163.50	188.30	174.14	12.33	12.83	13.50	12.89	0.98	1.01	1.05	1.01
200 ml Phosphorin	150.27	144.67	164.80	153.25	11.33	12.00	12.17	11.83	1.17	1.22	1.23	1.22
200 ml Pho. + 50% P (600 g SP)	153.00	148.70	170.33	157.35	12.00	12.33	12.67	12.33	1.15	1.21	1.21	1.19
300 ml Pho. + 25% P (300 g SP)	156.23	150.33	173.33	159.97	12.33	12.33	12.67	12.44	1.12	1.18	1.19	1.16
400 ml Phosphorin	155.67	151.67	175.00	160.78	12.33	12.67	12.83	12.61	1.10	1.16	1.18	1.15
Control (1200 g SP)	145.77	139.33	160.67	148.59	11.33	11.67	12.20	11.67	1.30	1.33	1.35	1.33
LS.D. 5%	3.37	2.67	2.84	2.96	0.47	0.57	0.40	0.48	0.11	0.07	0.10	0.09

Table (8): Effect of different phosphorus fertilization sources on sugar and vitamin C contents of Balady mandarin fruits during 2011, 2012 and 2013 seasons.

Characters / Treat.	Reducing sugars (%)				Total sugars (%)				V.C. (mg/g F.W.)			
Season	2011	2012	2013	Mean	2011	2012	2013	Mean	2011	2012	2013	Mean
100 ml yeast	31.6	3.29	3.56	3.34	8.19	9.22	9.32	8.91	51.00	52.67	52.67	52.11
100 ml yeast + 50% P (600 g SP)	3.32	3.29	4.34	3.65	9.11	9.29	10.25	9.55	52.67	53.00	53.06	52.91
150 ml yeast + 25% P (300 g SP)	3.50	3.30	4.34	3.71	9.38	9.72	10.38	9.83	53.17	53.33	56.44	54.31
200 ml Yeast	3.53	3.64	4.43	3.86	9.37	10.11	10.38	9.95	56.67	58.33	56.67	57.22
200 ml Phosphorin	2.53	3.89	3.01	2.81	7.52	8.29	8.10	7.97	46.67	48.33	50.33	48.44
200 ml Pho. + 50% P (600 g SP)	2.78	3.13	3.22	3.04	8.10	8.93	8.55	8.53	46.67	49.17	50.34	49.06
300 ml Pho. + 25% P (300 g SP)	2.86	3.13	3.40	3.13	8.22	9.01	8.93	8.72	47.53	51.00	51.89	50.14
400 ml Phosphorin	3.06	3.39	3.53	3.33	8.43	9.32	9.34	9.03	48.67	51.67	52.34	50.89
Control (1200 g SP)	2.51	2.65	2.73	2.63	7.62	8.43	8.20	8.09	43.80	45.33	45.89	45.01
LS.D. 5%	0.23	0.28	0.31	0.27	0.39	0.46	0.33	0.39	1.96	2.11	2.23	2.10

The maximum yield component were (2.10%, 363.89 fruit/tree and 63.18 kg/tree as av. the three studied seasons) due to use yeast at 200 ml/tree. Whereas, the minimum yield component were (1.55%, 288.91 fruit/tree and 43.40 kg/tree as av. the three studied seasons)

Recorded on the control treatment. Hence the increment percentage was (35.48, 25.95 and 45.58%) for fruit retention, number of fruits and yield/tree, respectively. Such finding might be related to the fact that phosphorus is very important for certain essential steps such as the accumulation and release of energy during photosynthesis process and cellular metabolism. Phosphorus is also a constituent of many organic compounds in plant.

4 – Fruit quality:

It is evident from data in Tables (7 & 8) that using either yeast or phosphoren whatever singly or combined with either 25 or 50% out of RPD significantly improved fruit quality in terms of increasing fruit weight, total soluble solids %, and sugar and vitamin C contents and decreasing the total acidity % compared to fertilization by the recommended phosphorus dose completely via mineral-P source (check treatment). Increasing the concentration of both materials was followed by gradual increment in fruit quality. No significant differences were recorded in fruit quality due use the yeast either at 200 ml/tree or combined yeast at 150 ml with 25% of RPD via mineral-P. Also, there was no significant difference due to use phosphorin either 400 ml or combined phosphorin at 300 ml with 25% of RPD via mineral-P. Using yeast was superior in improving fruit quality than using phosphorin. Using yeast at 200 ml/tree gave the best results with regard to fruit quality of Balady mandarin trees, since such treatment gave the heaviest fruit and highest values of total soluble solids % and sugar and vitamin C contents.

The highest fruit quality values attained (174.14g (fruit weight), 12.89% (T.S.S.%), 9.95% (Total sugar) and 57.22 (V.C) mg as av. the three studied seasons), due to use yeast at 200 ml/tree. On other hand, the least values of fruit quality (148.59g, 11.67%, 8.09% and 45.01 mg) were found on the check treatment trees. Then, the increment percentage was (17.19, 10.45, 22.99 and 27.13%) for fruit weight, T.S.S., total sugar and vitamin C contents, respectively. Such improvement is very important in citrus production since the increase in fruit weight and quality are the most important target than total yield due to the increase in fruit weight and quality induce an increase in packable yield. Therefore, using yeast at 200 ml/Balady mandarin trees was sufficient to get the high yield with good fruit quality.

Discussion and Conclusion:

Fertilization is one of the most important tools to improve the soil fertility and increase crop yield phosphorus is very important in the metabolic processes, i.e. blooming and flower development. It is the main constituent of energy compounds, phospholipids, nucleic acids, nucleotides and co-enzymes (Ahmed *et al*., 1995 and Attia *et al*. 2002). Major compensation to overcome the low fertility of soil is to use chemical fertilizers that became more expensive item for orchard management and environment pollution. Bio-fertilizers are otherwise called microbial inoculants, are the carrier based preparation containing beneficial microorganisms designed to improve the soil fertility and help the plant growth by increased number and biological activity in the rhizosphere (Subba Rao, 1984). The main sources of bio-fertilizers are bacteria, fungi and cyno-bacteria (El-Haddad *et al*., 1993). Using bio-fertilizers is considered a promising alternative for chemical fertilizers. It is very safe for human, animals and environment (Verna, 1990).

Recently using active dry yeast on fruit trees has received apparent interest. The positive effects of applying active yeast were attributed to its content of different nutrients, higher percentage of proteins, large amount of vitamin B and natural plant growth hormones, i.e. auxin and cytokinins as well as, chelating agent and enzymes produced. In addition, it contains some common amino acids approximately 18 amino acid and it is very effective in releasing CO_2 which improves net photosynthesis (Moor, 1979; Ferguson *et al*., 1987 and Idso *et al*., 1995). Nutritionally, yeast is heterotropic microorganisms and metabolically are usually fermentative producing a number of organic acids from sugars and carbohydrates as well as their high survival rate under extreme soil conditions, in transformation of rock phosphates and insoluble carbonate leading to increases in available phosphorus, Fe and other micronutrients (Vassileva *et al*., 2000). Such effect consider the most important amendment for soil reclamation and improvement especially for Egyptian soils having alkaline and high pH are induced a low in their available nutrients. This means that addition of yeast plus 25% out of RPD saved 75% of the recommended dose of phosphorus fertilization. In addition, avoiding P deficiency in the tree and P fixation in the soil.

Therefore, it can be concluded that using yeast as a P-fertilization was useful to improve the vegetative vigour and nutritional status of trees inducing an increase the yield and improve the fruit quality. These results emphasized the importance of phosphorus fertilization on get complete healthy trees. In addition, it reduce the need for mineral P and decreases the cost of production as well as environmental pollution problems.

The promotive effect of yeast application on growth, nutrient status and fruiting of citrus trees were emphasized by Abdel-Wahab (1999), Mostafa and El-Hasseiny (2001), Badawy, Sabah (2005) and El-Salhy *et al*. (2006).

The ability of phosphate solubilizing bacteria (phosphorin) to dissolve the precipitated forms of phosphorus, such as CO_3 $(PO_4)_2$ depends upon their efficiency in producing inorganic, organic acids and/or CO_2 (Zayed, 1998 and El-Dsouky and Attia, 1999).

The positive effect of phosphorin (phosphate slubilizing bacteria) may be attributed to it's a great role in contributing growth hormones such as auxin, gibberellins or cytokinins which could stimulate the plant growth (El-Sheekh, 1997). Also, phosphorin application may increase the number and activity of soil microorganisms in general and particular that consequently exert increases in the available-P and hence plant growth (El-Awag *et al*., 1993 and El-Dsouky and Attia, 1999). The above mentioned findings are in accordance with those obtained by Ahmed *et al*. (1995), Attia *et al*. (2002), Hegab *et al*. (2005), Mostafa (2006), Ismail-Omayma *et al*. (2011) and El-Khayat and Abdel-Rehiem (2013). They concluded that application of bio-fertilizer along with mineral-P source was effective for improving growth and fruiting aspects of citrus trees.

Conclusion:

Generally, it is concluded that applying yeast either 200 ml/tree only or combined yeast at 150 ml with 25% of RPD via mineral-P (300 g calcium superphosphae), as well as, phosphorin either 400 ml/tree only or combined phosphorin at 300 ml with 25% of RPD via mineral-P improve the nutritional status and fruiting of mandarin trees.

Moreover, soil inoculation with yeast or phosphorin improve the use efficiency of superphosphate through increasing the P availability and consequently, decreasing the amount of applied phosphatic fertilizer and reducing both the agriculture cost and the pollution impact of superphosphate.

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تأثير الخميرة ومصادر مختلفة من الأسمدة الفوسفاتية علي نمو واثمار أشجار اليوسفي البلدي

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الملخص:

أجريت هذه الدراسة خلال ثلاثة مواسم متتالية (٢٠١١، ٢٠١٢ و ٢٠١٣) علي أشجار اليوسفي البلدي بمزرعة كلية الزراعة – جامعة أسيوط – مصر. بهدف دراسة تأثير تلقيح التربة بالخميرة أو الفوسفاتين (مكون مذيب للفوسفات) فردياً أو خليطاً مع ٢٥-٥٠% من الأسمدة الفوسفاتية في صورة معدنية علي النمو الخضري والحالة الغذائية وإثمار أشجار اليوسفي البلدي.

ويمكن تلخيص أهم النتائج كما يلي:

- أدي استخدام الخميرة أو الفوسفاتين فردياً أو خليطاً إلي زيادة جوهرية في صفات النمو الخضري وحالة العناصر للأشجار مقارنة باستخدام الصورة المعدنية للتسميد الفوسفاتي فقط.
- أدي إضافة الخميرة أو الفوسفاتين فردياً أو خليطاً إلي تحسين محتوي الكربوهيدرات ونسبة المواد الكربوهيدراتية إلي النيتروجين بالأفرع مما أدي إلي زيادة جوهرية في مكونات المحصول وخصائص الثمار مقارنة باستخدام الصورة المعدنية فقط.
- أوضحت النتائج أفضلية استخدام التلقيح بالخميرة مقارنة بالتلقيح بالفوسفاتين.

من نتائج هذه الدراسة يتضح أهمية تلقيح التربة بالخميرة أو الفوسفاتين مع التسميد بمعدل ٢٥% من السماد الفوسفاتي الموصي به (٣٠٠ جم سوبر فوسفات) للشجرة. حيث يؤدي ذلك إلي تحسين النمو والحالة الغذائية للأشجار مع زيادة المحصول وخصائص الثمار. كما يؤدي ذلك إلي تقليل معدل التسميد الفوسفاتي مما يؤدي إلي تقليل تكاليف الإنتاج وتلوث البيئة.