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Influence of Using Compost Tea Enriched with Spirulina Plantensis Algae on Fruiting of Balady Lime Trees.

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Abstract:

The response of Balady lime trees (citrus aruntifollia) to application of inorganic N as well as compost tea enriched with *Spirulina plantensis* Algae was investigated during 2010 and 2011 seasons.

Results revealed that supplying the trees with recommended nitrogen rate (RN) through 75 % inorganic form plus 50 to 200 ml compost tea at 20 % per tree and *Spirulina plantensis* at 25 ml per tree was preferable more than using inorganic N alone at 75 to 100 %of the recommended rate in improving growth characters, nutritional status of the trees as well as yield, both quantitively and qualitatively of Balady lime trees. Application of compost tea enriched with spiruling plantensis surpassed than using compost tea alone in this respect.

Supplying Balady lime trees with RN (800 g/ tree/ year) through 75 % inorganic N + 100 ml compost tea 20 %/ tree + 25 ml *spirulina plantensis* Algae/ tree is suggested to be beneficial for improving yield and fruit quality.

Introduction:

Nitrogen fertilization is considered an important and limiting factor for fruiting of citrus crops (Nijjar, 1985). More studies are needed for finding out the best N management that was responsible for improving yield quantitively and qualitatively besides reducing environmental pollution. A great attention was realized to fulfill the requirements of citrus crops from organic and biofertilizers as an alternative to the inorganic fertilizers. Organic fertilizers not only increase organic matter % in the soil but also enhance the availability of most nutrients and water use efficiency (El- Haddad *et al*., 1993). Biofertilization has become in the last few decades a positive alternative to mineral fertilizers. It is beneficial in fixation of N and enhancing nutrient uptake, Biofertilizers secrete higher amounts of hormones, vitamins B and antibiotics (Higa and Wididana, 1991; Myint, 1999 and Kannaiyan, 2002). *Spirulina plantensis* is a photosynthetic blue green micro alga. It is considered an essential biofertilizer and has been largely studied due to its commercial importance as a source of proteins, vitamins, essential amino acids and fatty acids (Leduy and Thorein, 1977; Ciferri and

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Tibani, 1985; Vonshak and Richmond, 1985 and Vonshak, 1986). Enriched organic fertilizers with biofertilizers especially *Spirulina plantensis* algae are beneficial in improving yield quantitively and qualitatively rather than application of organic fertilizers alone (Ahmed *et al*., 2011b).

Using organic and biofertilization as a partial replacement for mineral N fertilizers was revealed by many authors for improving fruiting of different fruit crops (Kabeel *et al*., 2005; Mouftah, 2007; Barakat *et al*., 2007; Mohamed and Ahmed, 2008; Abdo,2008;El- Sehrawy, 2008; Shaalan- Nashwh, 2008; Seleem-Basma and Telep, 2008; Abada, 2009; Gad El- Kareem, 2009; Ahmed *et al*., 2011a; Abd El-Aziz, 2011; Uwakiem, 2011; Mahfouz, 2011; Refaai, 2011; Ibrahiem, 2012; Mahmoud, 2012 and Mohamed- Shaimaa, 2012).

The target of this study was: adjusting N management for Balady lime trees grown under sandy soil. Suggesting the best organic and *Spirulina plantensis* treatment as a partial substitute of mineral N fertilizer is considered another goal.

Materials and Methods:

This study was conducted during 2010 and 2011 seasons on 25- years old nucellar Balady lime (citrus aruntifollia) trees that were grown in a private orchard situated at Derwa village, Mallawy district, Minia Governorate. Trees are planted at 6 × 6 meters apart. The soil of the orchard is a sandy well drained with a water table not less than two meters deep. Physical and chemical analyses of the tested soil at 0.0 – 100 cm deep were tested according to Chapman and Pratt (1965) and the obtained data are shown in Table (1).

Table (1): Analysis data for the investigated soil:

Particle size distribution:	**Values**
Sand %	83.0
Silt %	12.5
Clay %	4.5
Texture%	Sandy
pH (1:2.5 extract)	8.0
E.C (1:2.5 extract) (mm hos/ cm)	1.11
O.M. %	0.80
Total $CaCO_3$ %	7.8
Total N %	0.04
Available P (ppm, Olsen)	1.5
Available K (ppm, ammonium acetate)	16.0

The experiment included the following eight treatments:-

1- Application of RN (800 g/ tree/ year) (according to Ebrahiem *et al*., 2002) completely via inorganic N form only 2.39 kg ammonium nitrate (33.5 % N)/ tree/ year.

2- Application of (RN) through 75 % inorganic form (1.79 kg

ammonium nitrate / tree/ year) alone.

3- Application of RN through 75 % inorganic form (1.79 kg ammonium nitrate / tree/ year) + 50 ml compost tea at 20 %/ tree/ year.

4- Application of RN through 75 % inorganic form + 100 ml compost tea at 20 %/ tree/ year.

5- Application of RN through 75 % inorganic form + 200 ml compost tea at 20 %/ tree/ year.

6- Application of RN through 75 % inorganic form (1.79 kg ammonium nitrate / tree/ year) + 50 ml compost tea at 20 %/ tree/ year + 25 ml *Spirulina plantensis* Algae / tree/ year

7- Application of RN through 75 % inorganic form + 100 ml compost tea at 20 %/ tree/ year + 25 ml *Spirulina plantensis* Algae / tree/ year.

8- Application of RN through 75 % inorganic form + 200 ml compost tea at 20 %/ tree/ year + 25 ml *Spirulina plantensis* Algae / tree/ year.

Each treatment was replicated three times, one tree per each. Mineral N fertilizer source namely ammonium nitrate (33.5 % N) was divided into two equal batches at spring growth start and again just after fruit setting. Compost tea was prepared by dissolving 20 kg compost (13.1 moisture; 53.4 O.M.; 46 % ash, 1.69 % N; 0.95 % P_2O_5; 2.04 K_2O; 0.84 % Mg; 411 ppm Fe; 428 ppm Zn; 462 ppm Mn, 48 ppm B and 65 ppm Cu according to the procedures of Chapman and Pratt, (1965) in 100 L water for three days. The supernatant was taken for application at levels as previously mentioned (50 , 100 or 200 ml/ tree/ year) via soil. It was applied at four times namely: just at growth start, just after fruit setting and at one month intervals.

Spirulina plantensis was obtained from Microbiology Res. Department, Soil, Water and Environment Research Center (ARC), Giza, Egypt. The Algae was grown in one liter Erlenmeyer flasks containing 500 ml of a standard synthetic medium under continuous illumination (200 lux). The flasks were incubated at 35° C ± 2° C. After 30 days of incubation the culture was transferred to glass- reactor (4 liter) and maintained under aerobic conditions using filtered compressed air and incubation at 37 °C for 21 days. *Spirulina plantensis* culture concentration of 2.54 nm was measured spectrophotometrically at 560 nm (Leduy and Thorien, 1977) pH (1.51) and dry weight (2.63 gl^{-1}) were estimated according to Vonshak (1986). Chlorophyll- a (23.5 mgl^{-1}) was determined by the method of Vonshak and Richmond (1988). Horticultural practices such as irrigation, hoeing as well as pest and fungi control were carried out as usual.

Some characteristics of *spirulina plantensis* are shown in Table (2):

Table (2): Some characteristics of *spirulina plantensis*:

Characteristics	Values
Color	Blue green
pH	10.51
EC (dS mm^{-1})	19.3
Organic matter (gl^{-1})	2.72
Organic carton (gl^{-1})	1.60
Total nitrogen (gl^{-1})	0.70
Total phosphorus (gl^{-1})	0.50
Total potassium (gl^{-1})	2.34

This experiment was set up in a completely randomized block design with three replicates, one tree/ replicate. The experiment contained twenty-four trees.

Four branches, one- year old were chosen on each tree, one toward each direction. Four shoots from the current Spring growth were labeled for measuring shoot length (cm.) and leaf area (cm^2) (Ahmed and Morsy, 1999). Twenty mature leaves (7 months old) were picked at random from non fruiting shoots in the Spring growth cycle per each tree (the first week of Sept.) (Summer, 1985). The leaves were oven dried at 70 ° C and analyzed for their content of N, P and K (on dry weight basis) using the standard procedures that outlined by Chapman and Pratt (1965).

Final fruit setting percentage was recorded. Yield was harvested at two- week intervals started at the last week of July and ended at the end of Dec. At the end of Dec., cumulative yield expressed in weight (kg.) and number of fruits per tree were recorded.

Fifty fruits were taken randomly at the commercial harvesting date for the determination of the following physical and chemical characteristics of the fruits:

1- Fruit weight (g.).

2- Fruit dimension (height and diameter in cm.).

3- Percentage of juice.

4- Fruit peel thickness (cm.).

5- Percentage of total soluble solids.

6- Percentage of total acidity (expressed as g citric acid/ 100 ml juice) (A.O.A.C., 1995).

7- Ascorbic acid content (as g/ 100 ml juice) by using 2.6 dichlorophenol endophenol dye (A.O.A.C., 1995).

All the obtained data were tabulated and statistically analyzed according to Mead *et al*., (1993). For comparing the significant difference among various treatment, New L.S.D test at 5 % was used.

Results and Discussion:

1- Shoot length and Leaf area and its content of N, P and K:

Data in Tables (3) clearly show that application of the N (800 g/ tree/ year) through 75 % inorganic N + 50 to 200 ml compost tea with or without *Spirulina plantensis* Algae at 25 ml/ tree/ year significantly increased the two growth characters namely

shoot length and leaf area as well as percentages of N, P and K in the leaves comparing with using N completely via inorganic N source at 75 to 100 %. Increasing the levels of compost tea at 20 % from 50 to 200 ml/ tree/ year either enriched with *Spirulina plantensis* Algae or non- enriching with such Algae resulted in a gradual promotion on such two growth characters and these nutrients. No significant effect was attributed to increasing levels from 100 to 200 ml of compost tea. Soil addition of *Spirulina plantensis* algae was significantly effective in promoting these parameters rather than non- application. The best results were obtained with treating the trees with N via 75 % inorganic + 200 ml compost tea at 20 % + 25 ml *Spirulina plantensis* algae per tree/ year. Supplying the trees with N as 75 % inorganic form only gave the lowest values. These results were true during 2010 and 2011 seasons.

These results are in harmony with those obtained by Mouftah (2007); Shaalan- Nashwah (2008); Mohamed- Shaimaa (2012) and Ibrahiem (2012).

2- Percentage of fruit setting and yield/ tree:

Table (4) shows that varying N management had significant effect on fruit setting % number of fruits per tree and yield expressed in weight (kg.). Fertilizing of the trees with N through 75 % inorganic + 50 to 200 ml compost tea at 20 % + 25 ml *Spirulina plantensis* algae significantly improved fruit setting % number of fruits per tree and yield expressed in weight comparing with using N completely via inorganic N (at 75 to 100 %). The promotion was associated with increasing compost tea levels from 50 to 200 ml/ tree/ year. Using compost tea enriched with *Spirulina plantensis* was significantly superior to the application of compost tea alone in this connection. This shows the essential role of such algae on activating the analysis and breakdown of compost tea. In most cases, increasing the levels of compost tea from 100 to 200 ml/ tree/ year failed to show significant promotion on fruit setting %, number of fruits and yield weight. Therefore, the recommended level of compost tea at 20 % was 100 ml/ tree/ year. The promised treatment comprised from the application of the N through 75 % inorganic N + 100 ml/ tree compost tea at 20 % + 25 ml/ tree *Spirulina plantensis* algae. Under such striked treatment, yield/ tree reached 94.6 and 98.7 kg in relative to 67.7 and 72.8 kg produced by control (received N via 100 % inorganic) trees during both seasons, respectively. Percentage of yield increment with applying such recommended treatment reached 39.7 and 35.6 % in relative to the check treatment (application of N completely via inorganic form), during both seasons, respectively.

These results are in harmony with those obtained by Mouftah (2007); Shaalan- Nashwah

(2008); Mohamed- Shaimaa (2012) and Ibrahiem (2012).

3- Some physical and chemical characteristics of the fruits:

It is clear from the data in Tables (5& 6) that both physical and chemical characteristics of the fruits were significantly varied among different N management treatments. Application of N via 75 % inorganic + 50 to 200 ml compost tea + 25 ml *Spirulina plantensis* algae significantly improved fruit quality in terms of increasing fruit weight and dimensions (height and diameter), juice%, total soluble solids %, total acidity % and ascorbic acid and reducing fruit peel thickness comparing with using N completely via inorganic source only. The improvement in fruit quality was associated with increasing compost tea levels from 50 to 200 ml. A significant improving in fruit quality was observed among using compost tea enriched with *Spirulina plantensis* and using compost tea alone. The best results with regard to quality of the fruits were obtained with using N through 75 % inorganic + 100 ml compost tea + 25 ml *Spirulina plantensis* algae, since no measurable promotion was detected among the higher two levels of compost tea namely 100 and 200 ml/ tree/ year.

These results are in harmony with those obtained by Mouftah (2007); Shaalan- Nashwah (2008); Mohamed- Shaimaa (2012) and Ibrahiem (2012).

The previous positive action of compost tea enriched with *Spirulina plantensis* algae on fruiting could be attributed to their essential role on enhancing both physical and chemical fertility of the soil, increasing nutrient uptake and secreting natural hormones and antibiotics (Kannaiyan, 2002).

As a conclusion, for improving the yield of Balady lime trees quantitively and qualitatively, it is advised to fertilize the tree yearly with N through 75 % inorganic N + 100 ml compost tea at 20 % + 25 ml *Spirulina plantensis* algae.

Table (3): Effect of inorganic N as well as compost tea enriched with *Spirulina plantensis* Algae on shoot length (cm.), leaf area (cm^2) as well as percentages of N P and K in the leaves of Balady lime trees during 2010 and 2011 seasons.

Treatment	**Shoot length (cm.)**		**Leaf area (cm^2)**		**Leaf N %**		**Leaf P %**		**Leaf k %**	
	2010	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
100 % in-organic N	6.6	6.9	14.3	14.0	1.80	1.73	0.18	0.16	1.77	1.81
75 % inor-ganic N	6.1	6.4	13.6	13.3	1.71	1.65	0.22	0.20	1.82	1.86
75 % inor-ganic + 50 ml compost tea	7.2	7.5	15.0	14.7	1.88	1.81	0.26	0.23	1.90	1.94
75 % inor-ganic + 100 ml compost tea	7.9	8.2	15.8	15.6	1.94	1.90	0.32	0.30	1.97	2.01
75 % inor-ganic + 200 ml compost tea	8.0	8.3	15.9	15.6	1.95	1.91	0.33	0.31	1.98	2.02
75 % inor-ganic + 50 ml compost tea + S	8.4	8.8	16.5	16.2	2.07	1.99	0.36	0.33	2.04	2.09
75 % inor-ganic + 100 ml compost tea + S	8.9	9.5	17.0	16.7	2.18	2.09	0.39	0.38	2.11	2.15
75 % inor-ganic + 200 ml compost tea + S	9.0	9.6	17.1	16.8	2.19	2.10	0.40	0.39	2.12	2.16
New L.S.D at 5 %	**0.3**	**0.3**	**0.4**	**0.5**	**0.06**	**0.06**	**0.03**	**0.03**	**0.04**	**0.04**

S = *Spirulina plantensis* Algae

Table (4): Effect of inorganic N as well as compost tea enriched with *Spirulina plantensis* Algae on the percentage of K in the leaves, fruit set %, yield/ tree (kg.) and number of fruits/ tree of Balady lime trees during 2010 and 2011 seasons.

Treatment	**Fruit set %**		**No. of fruits/ tree**		**Yield/ tree (kg.)**	
	2010	**2011**	**2010**	**2011**	**2010**	**2011**
100 % inorganic N	5.4	5.5	3300.0	3356.0	67.7	72.8
75 % inorganic N	5.0	5.1	3001.0	3055.0	60.0	63.2
75 % inorganic + 50 ml compost tea	5.8	6.0	3500.0	3555.0	73.5	76.8
75 % inorganic + 100 ml compost tea	6.2	6.5	3700.0	3750.0	79.9	83.3
75 % inorganic + 200 ml compost tea	6.3	6.6	3750.0	3770.0	81.4	84.1
75 % inorganic + 50 ml compost tea + S	6.7	7.0	3950.0	4000.0	87.7	91.6
75 % inorganic + 100 ml compost tea + S	7.0	7.4	4150.0	4200.0	94.6	98.7
75 % inorganic + 200 ml compost tea + S	7.1	7.5	4155.0	4220.0	95.1	99.6
New L.S.D at 5 %	**0.3**	**0.3**	**160.0**	**161.0**	**1.7**	**1.8**

Table (5): Effect of inorganic N as well as compost tea enriched with *Spirulina plantensis* Algae on some physical characters of the fruits of Balady lime trees during 2010 and 2011 seasons.

Treatment	Fruit weight (g.)		Fruit height (cm.)		Fruit diameter (cm.)		Juice %	
	2010	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
100 % inorganic N	20.5	21.7	3.73	3.70	3.23	3.20	40.0	39.8
75 % inorganic N	20.0	20.7	3.64	3.60	3.14	3.10	38.2	38.0
75 % inorganic + 50 ml compost tea	21.0	21.6	3.80	3.77	3.30	3.27	42.0	41.8
75 % inorganic + 100 ml compost tea	21.6	22.2	3.85	3.82	3.35	3.32	44.0	43.8
75 % inorganic + 200 ml compost tea	21.7	22.3	3.86	3.83	3.36	3.33	44.5	44.2
75 % inorganic + 50 ml compost tea + S	22.2	22.9	3.92	3.90	3.42	3.40	46.0	45.7
75 % inorganic + 100 ml compost tea + S	22.8	23.5	3.97	3.95	3.47	3.45	48.0	47.8
75 % inorganic + 200 ml compost tea + S	22.9	23.6	3.98	3.96	3.48	3.46	48.3	48.0
New L.S.D at 5 %	**0.4**	**0.4**	**0.05**	**0.05**	**0.04**	**0.04**	**1.7**	**1.6**

Table (6): Effect of inorganic N as well as compost tea enriched with *Spirulina plantensis* Algae on some physical and chemical characteristics of the fruits of Balady lime trees during 2010 and 2011 seasons.

Treatment	Peel thickness (cm.)		T.S.S %		Total acidity %		Ascorbic acid content (mg/ 100 ml)	
	2010	2011	2010	2011	2010	2011	2010	2011
100 % inorganic N	0.18	0.19	7.3	8.0	6.92	7.20	34.0	35.0
75 % inorganic N	0.16	0.17	7.0	7.7	6.51	6.82	32.0	33.0
75 % inorganic + 50 ml compost tea	0.14	0.15	7.6	8.3	7.10	7.50	37.0	38.3
75 % inorganic + 100 ml compost tea	0.14	0.15	7.9	8.6	7.40	7.79	39.3	40.5
75 % inorganic + 200 ml compost tea	0.14	0.15	8.0	8.7	7.42	7.80	40.0	41.3
75 % inorganic + 50 ml compost tea + S	0.14	0.15	8.3	9.0	7.59	8.10	43.0	44.4
75 % inorganic + 100 ml compost tea + S	0.14	0.15	8.7	9.4	8.20	8.50	46.0	47.0
75 % inorganic + 200 ml compost tea + S	0.14	0.15	8.8	9.5	8.22	8.55	46.5	47.3
New L.S.D at 5 %	**0.02**	**0.02**	**0.2**	**0.2**	**0.17**	**0.18**	**2.1**	**2.0**

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تأثير استخدام مستخلص الكمبوست المزود بطحلب الأسبيريولينا بلاتنسيس علي الإثمار في أشجار الليمون البلدي

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[2]قسم البساتين – كلية الزراعة – جامعة المنيا – مصر.

تم دراسة درجة استجابة أشجار الليمون البلدي لاستخدام السماد النيتروجيني الغير عضوي جنبا إلي جنب مع مستخلص الكمبوست المزود بطحلب الاسبيرولينا بلاتنسيس وذلك خلال موسمي 2010 ، 2011.

أوضحت نتائج الدراسة أن تسميد الأشجار بالكمية الموصى بها من النيتروجين (800 جرام للشجرة فى العام) من خلال 75 % سماد غير عضوي جنبا إلي جنب مع مستخلص الكمبوست الذي تركيزه 20 % بمعدل 50 إلي 200 مل للشجرة المزود بطحلب الاسبيرولينا بلانتنسيس بمعدل 25 مل للشجرة كان مفضلا عن استخدام الكمية الموصى بها من النيتروجين علي هيئة 75 % سماد غير عضوي فقط في تحسين صفات النمو الخضري والحالة الغذائية للأشجار وكمية المحصول كما ونوعا وقد تفوق استخدام مستخلص الكمبوست المزود بطحلب الاسبيرولينا بلاتنسيس عن استخدام مستخلص الكمبوست فقط في هذا الصدد.

وعليه يمكن التوصية بتسميد أشجار الليمون البلدي بالكمية الموصى بها من النيتروجين (800 جرام للشجرة في العام) من خلال 75 % سماد غير عضوي + 100 مل مستخلص كمبوست بتركيز 20 % + 25 مل طحلب الاسبيرولينا بلاتنسيس/ الشجرة/ العام وذلك لزيادة كمية محصول الشجرة وتحسين خصائص الجودة للثمار.