J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 3 (1): 41 - 51, 2012

EFFECT OF BALANCED FERTILIZER SPLITTING ON NAVEL ORANGE YIELD AND FRUIT QUALITY

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ABSTRACT

Three balanced fertilizer levels, L_1 (495g N +101.5 g P+ 400 g K + 50 g S + 2.5 g Mg + micronutrients mixture) of (300,150,100,50,50 mg kg^{-1} of Fe, Mn, Zn, Cu, B) ; L_2 (990 g N + 203 g P+ 800 g K+ 50 g S+ 5g Mg + the previous micronutrients mixture and L_3 (1485 g N+ 304.5g P +1200g K + 50g S+ 7.5g Mg + the previous micronutrients mixture compared to the farmer treatment (495 g N+ 101.5 g P) /tree/ year.Treatments were applied to mature navel orange trees which cultivated under the conditions of Metobas District, Kafr El-Sheikh Governorate, Egypt, during two successive seasons of 2007 - 2008 and 2008 – 2009. Randomized complete block design was used with four replicates (one tree = replicate). The three balanced fertilizer levels were divided into four splitting treatments (3, 6, 9 and 12 doses). The first and second treatments were added one dose / month. The third and fourth treatments were added one dose / 15 days. All treatments started at mid March in both seasons. The obtained results can summarized to:

The balanced fertilizer level (L_3) had the highest values of chlorophyll A (89.9 and 94.1 µg/ cm^2), chlorophyll B (71.8 and 75.7 µg/cm^2), total chlorophyll (161.7 and 169.8 µg / cm^2), nitrogen (2.62, and 2.62%), phosphorus (0.054 and0.057%) , potassium (1.67 and 2%), for leaves , fruit set (6.4, and 6.4%), fruit yield (138.2 and 133.5 kg/ tree/ year), soluble solid content (SSC) (11.5% and 11.8%), acidity (0.98 and 0.97%), vitamin C (V.C) (57.8 and 56.7 mg /100 ml juice), reducing sugars (4.2, and 4.2%) and total sugars (7.4 and 7.3%) in the first and second seasons, respectively. While it had the lowest values for pre-harvest drop fruits (7.1 and 6.6%) in the first and second seasons, respectively. On contrary the lowest values of the mentioned parameters were recorded with the farmer treatment. In respect to fertilizer splitting the highest values of the previous parameters were obtained with the treatments splitted into 6 doses of balanced fertilizers.

Keywords: Citrus, balanced fertilizer, splitting, navel orange, fruit quality

INTRODUCTION

Citrus trees require large quantities of mineral nutrients to attain adequate growth and yield, The requirements for some kinds of the nutrients vary with soil type and fertility. The Egyptian soils varied with respect to their texture from sandy to heavy clay soils. Average value of total soluble nitrogen is very low, in spite of the organic matter is very low. So, the soil reactions are slightly alkaline, the available phosphorus values is moderate and the available potassium ranged between low and high. Fruit yield of citrus is largely dependent on balanced of some macro and micro element. Also, nitrogen fertilization plays an important role in tree nutrition. Increasing nitrogen fertilization from 227 to 1135 g N per tree annually significantly increased fruit yield represents 20% increase in yield (Sanchez *et al.*, 2002 and Glenn Wright, 2009). In respect to fertilizer losses Mongi and Robert

(1991) found that compared to the controlled –release fertilizers, the soluble fertilizers were more readily available but had shorter residual effects on leaf, soil nitrogen and potassium concentration. Earlier research work has demonstrated that, limited phosphorus availability of low fertility tropical soils impairs citrus production (Quaggio *et al.*, 2002). Greater growth of citrus plants corresponded to greater root development as evaluated by root growth rate and architecture, these parameters varied according to phosphorus availability in soil (Dircen Mattos *et al.*, 2010). On the other hand Thomas Obreza (2001) found that excessive phosphorus can adversely affect citrus growth and development, especially fruit quality. High phosphorus fertilization has lowered juice soluble solids concentration and caused delayed external color development and re-greening oranges.

Potassium plays a critical role in citrus trees and it affects many phenomena, both visible and invisible, the requirement for potassium in trees is next to that for nitrogen and ranges from 0.5 to 2% of dry matter. According to various sources, one ton of oranges exports an average of 2.5 Kg K_2O, corresponding to 125-250 Kg ha^{-1} according to the yield potential. Potassium has dominant effects on external and internal fruit qualities, including yield, color, size, acidity and roughness. Excessively high potassium levels result in large fruits with course, thick peel and poor color. Moreover early and intensive re-greening will occur (Erner *et al.*, 2002). The high concentrations of potassium in the cytosol and chloroplast neutralize the soluble and insoluble macromolecular anions and stabilizes the pH in these compartments (Marchner, 1995). Malavolta, (1992) reported that potassium fertilization increased orange fruit production up to leaf potassium concentrations of 1.5-1.7%. Du -Plesis and Koen (1988) emphasized the importance of the ratio between N and K, they found a maximum yield at the high N:K ratio of 2.8 with the N and K contents exceeding 2.1 and 0.8%, respectively. As the ratio diminished to 1.6 with N and K contents exceeding 1.8 and 0.9%, respectively, the fruit size increased.

There four objectives of the present study are to investigate:

1- Effect balanced fertilizer on yield and quality of navel orange fruit .

2- Effect of splitting balanced fertilizer on yield and quality of navel orange fruit.

3- Effect of splitting balanced fertilizer on soil fertility and N, P and K concentration in leaves.

4 - Optimizing the mineral fertilizers .

MATERIALS AND METHODS

Thirteen treatments of balanced fertilizer levels and splitting were conducted during two successive seasons of 2007-2008 and 2008-2009 on navel orange mature trees, at Metobas District Kafr El-Sheikh Governorate, Egypt. The experiment region at latitude 31^{O}, 27 N and longitude 31^{O} 32 E. The aim of the present study was to investigate the effect of three balanced fertilizer levels and their splitting (3, 6, 9 and 12 doses) in 3 and 6 doses (one dose monthly), started in mid March and in 9 and 12 doses (one dose every

15 days) started in mid March on yield and quality of orange fruits compared to the farmer treatment (control). Randomized complete blocks design was used with four replicates. Treatments could be illustrated as follow:-

No.	splitting	Nutrients g/ tree/ year
1 (control)		495 g N + 101.5 g p (232.5 g P_2O_5) per tree/ year/ farmer treatment
2	three doses	495 g N + 101.5 g p +400 g k + 50 g S + 2.5 g Mg + micronutrients mixture (L_1)
3		990 g N + 203 g P + 800 g K + 50 g S+ 5 g Mg + micronutrients mixture / tree/ year (L_2)
4		1485 g N + 304.5 g P + 1200 g K+ 50 g S + 7.5 g Mg + micronutrients mixture/ tree/ year (L_3)
5	6 doses	495 g N + 101.5 g P + 400 g K + 50 g S+ 2.5 g Mg + micronutrients mixture/ tree/ year (L_1)
6		990 g N + 205 g P + 800 g K + 50 g S + 5 g Mg + micronutrients mixture/ tree/ year (L_2)
7		1485 g N + 304.5 g P + 1200 g K + 50 g S + 7.5 g Mg + micronutrients mixture/ tree/ year (L_3)
8	9 doses	495 g N + 101.5 g P + 400 g K + 50 g S + 2.5 g Mg + micronutrients mixture/ tree/ year (L_1)
9		990 g N + 203 g P + 800 g K + 50 g S + 5 g Mg + micronutrients mixture/ tree/ year (L_2)
10		1485 g N + 304.5 g P + 1200 g K + 50 g S + 7.5 g Mg + micronutrients mixture/ tree/ year (L_3)
11	12 doses	495 g N + 101.5 g P + 400 g K + 50 g S + 2.5 g Mg + micronutrients mixture/ tree/ year (L_1)
12		990 g N + 203 g P + 800 g K + 50 g S + 5 g Mg + micronutrients mixture/ tree/ year (L_2)
13		1485 g N + 304.5 g P + 1200 g K + 50 g S + 7.5 g Mg + micronutrients mixture/ tree/ year (L_3)

Nitrogen was applied as ammonium nitrate 33% N, phosphorus was applied as a super phosphate calcium 15.5% P_2O_5 (6.77% P), potassium was applied as potassium sulphate 48% K_2O (40% k), magnesium was applied as magnesium sulphate (8.9% Mg), sulphur was applied as sulphur metal and micronutrients were applied as a mixture of 300, 150, 100, 50 and 50 mg kg^{-1} of the applied fertilizer from cheleated Fe, Mn, Zn, Cu and B as Boric acid, respectively. Just mature leaves samples were collected from the different treated trees, chlorophyll A, B and total chlorophyll were determined according to Moran and Porath (1982). The samples were oven dried, finely ground, wet digested using sulphoric – perchloric acids mixture. Total nitrogen was determined in the digestion by micro Kjledahel method, phosphorus was determined color meterically by spectrophotometer and potassium was measured by flamephotometer according to Jackson, (1958). Representative soil sample was collected from the soil before the treatment, prepared and analyzed for some soil chemical and physical properties according to Black *et al.*, (1965). Some soil physical and chemical characteristics are presented in Table 1. Yield and yield affect characters were determined i.e., fruit set %, pre-harvest drop%, fruit weight, fruit number/ tree and fruits weight kg/ tree. Some fruit and juice qualities properties were determined i.e., acidity%, vitamin C mg/100 ml juice, reducing sugars%, non reducing sugars% and total sugars% as well as soluble solid content (SSC)% according to A.O.A.C (1965).

Table 1: Some physical and chemical properties of the experimental soil.

Season	Particle size distribution			Texture	pH	EC dSm^{-1}	O.M%	Available nutrient mg kg^{-1}		
	Sand%	Silt%	Clay%					N	P	K
2007/2008	23.4	43.9	32.7	Silty clay	7.2	1.30	1.92	29	6.2	211
2008/2009	23.4	43.9	32.7	Silty clay	7.4	1.39	1.88	33	6.4	225

***pH measured in 1: 2.5 soil : water suspensions. *EC determined in soil paste extract.**

RESULTS AND DISCUSSION

Leaf chlorophyll (A and B) and N, P and K%

Data presented in Table 2 show that increasing the balanced fertilizer levels led to high significantly increases of chlorophyll A, B and total chlorophyll in both seasons. The high fertilizer level had the highest values of chlorophyll A (89.9 and 94.1 µg/ cm^2), chlorophyll B (71.8 and 75.7µ g/cm^2) and total chlorophyll (161.7 and 169.8 µg/ cm^2) in the first and second seasons, respectively. On the other hand the lowest chlorophyll A, B and total values were observed with the lowest balanced fertilizer level in both seasons. Splitting of balanced fertilizer high significantly affected chlorophyll contents. The highest values of chlorophyll A (89.1 and 91.7 µg/ cm^2) were obtained with splitting the fertilizer into 6 and 9 doses in the first and second seasons, respectively. The highest values of chlorophyll B (70.3 and 74.4 µg/cm^2) and total chlorophyll (159.3 and 165.7 µg/cm^2) were obtained with splitting into 6 doses in the first and second seasons, respectively. In respect to the interaction between fertilizer levels and number of splitting, the highest values of chlorophyll A (95.5 and 95.0 µg/ cm^2), chlorophyll B (76.6 and 81.4 µ g/ cm^2) and total chlorophyll (169.1 and 176.3 µg/ cm^2) were obtained with the highest balanced fertilizer level (L_3) and splitting the fertilizer into 6 doses in the first and second seasons, respectively. The highest balanced fertilizer level (L_3) had the highest nitrogen percentage (2.62 and 2.62%), highest phosphorus percentage (0.054 and 0.057%) and highest potassium percentage values in the new mature leaves (1.67 and 1.62%) in the first and second seasons, respectively.

Splitting the balanced fertilizer into 6 doses had the highest phosphorus percentage values in the new mature leaves (0.050 and 0.051%)in both seasons, respectively and the highest nitrogen percentage value in the second season only (2.61%). While splitting the fertilizer into 9 doses had the highest nitrogen percentage value in the first season (2.7%) and the highest potassium percentage values (1.57 and 1.48%) in the first and second seasons, respectively.

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The obtained results may be due to increasing the fertilizer levels and splitting the fertilizer led to decrease the nutrients losses by leaching or/ and volatilization, increased available nutrients in the root zone at long period which enhanced nutrients absorption and increasing chlorophyll content. These results are agreement with those obtained by Mongi and Robert (1991) who reported that the soluble fertilizers were more readily available but had shorter residual effects on leaf and soil nitrogen and potassium concentration.

Fruit yield and fruit physical properties

Data presented in Table 3 show that increasing fertilizer levels high significantly increased orange fruit set%. The highest fruit set values (6.4 and 6.4%) were obtained with (L_3) level in the first and second seasons, respectively. On the other hand the lowest fruit set values (5.1 and 5.3%) were obtained with the farmer treatment in the first and second seasons, respectively.

Splitting the fertilizer into 6 doses had the highest fruit set values (6.6 and 6.9%) in the first and second seasons, respectively. The interaction between fertilizer levels and fertilizer splitting effect show that the highest fruit set values (7.2 and 7.4%) were obtained with the highest fertilizer level (L_3) and splitting the fertilizer into 6 doses. Pre-harvest fruit drop significantly affected by the fertilizer levels, where the lowest pre-harvest fruit drop values (7.1 and 6.6%) were obtained with (L_3). In respect to fertilizer splitting, the lowest pre-harvest fruit drop (6.9 and 7.0%) were recorded with splitting the fertilizer into 6 doses. Effect of the interaction between the fertilizer levels and fertilizer splitting showed that the lowest values were observed with the highest fertilizer level (L_3) and splitting the fertilizer into 6 doses of 6.1 and 5.5% in the first and second seasons, respectively. On the other hand the highest pre-harvest drop values (9.1 and 9.9%) were recorded with the farmer treatment in the first and second seasons, respectively. Fruit weight and fruit number had the same trend, (L_2 and L_3) had approximately the same weight and fruit number values. Splitting the fertilizer into 6 doses had the highest fruit weight (271.4 and 263.1 g) in the first and second seasons, respectively. Also the highest fruit number values (555.3 and 526.5 g) were obtained with splitting the fertilizer into 9 and 6 doses in the first and second seasons respectively. Orange yield kg tree^{-1} were significantly affected by fertilizer levels and splitting. The highest yield values of 140.5 and 133.5 Kg/ tree were obtained with L_2 in the first season and L_3 in the second season. On the other hand the lowest yield values of 129.0 and 120.1 kg tree^{-1} were observed with the farmer treatment in the first and second seasons, respectively. Splitting the balanced fertilizer significantly affected orange yield. The highest yield values of 146.4 and 138.0 kg tree^{-1} were obtained with splitting the fertilizer into 6 doses, while the lowest values of 129.0 and 123.2 kg tree^{-1} were observed with splitting the fertilizer into 3 doses. In respect to the interaction between the fertilizer levels and fertilizer splitting, the highest yield values of 156.4 and 141.1 kg tree^{-1} in the first and second seasons, respectively were obtained with L_2 and splitting to 6 doses. The notice increase in orange yield may be due to increasing fruit set and decreasing pre-harvest fruit drop.

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These results are in agreement with those obtained by Malavolta, (1992) who reported that potassium fertilization increased orange fruit production up to concentration of 1.5 – 1.7% in the leaf. And Glenn Wright, (2009) who reported that increasing nitrogen fertilization from 227 to 1135g N/ tree annually increased fruit yield represents 20% increase.

Fruit chemical properties

Data presented in Table 4 show that, increasing the balanced fertilizer levels significantly increased SSC% in both seasons. The lowest SSC% values (9.9 and 10%) were observed with the farmer treatment in the first and second seasons, respectively. On the other hand the highest values (11.5 and 11.8%) were obtained with L_3 level in the first and second seasons, respectively. Splitting the fertilizer into 6 doses led to significantly increase of SSC% (11.6%) in both seasons.

Acidity % was increased gradually with increasing the fertilizer levels, where the mean values of L_1, L_2 and L_3 were (0.96 and 0.93%), (0.97 and 0.95%) and (0.98 and 0.97%) compared with farmer treatment (0.92 and 0.91%), in the first and second seasons, respectively. Similar results were reported by Erner *et al.*, (2002) who reported that, potassium has dominant effects on external and internal orange fruit qualities.

Vitamin C values significantly increased with increasing the fertilizer levels. The highest values 57.8 and 56.7 mg/100 ml juice were obtained with L_3 level in the first and second seasons, respectively. On the other hand the lowest values of 51.9 and 51.5 mg/100 ml juice were obtained with the farmer treatment. Reducing sugars % had the same trend, where the highest value (4.2%) in both seasons was obtained with L_3 fertilizer level, and splitting the fertilizer into 6 doses produced the highest value of 4.0% in the two seasons. No reducing sugars % and total sugars % had the same trend, where the highest values were obtained with L_3 fertilizer level and splitting the fertilizer into 6 doses in both seasons. These may be due to low soil fertility and balanced fertilization in long period which produced healthy trees and best fruit qualities. These results in harmony with those obtained by DU-Plesis and Koen (1988), Marchner, (1995), Thomas Obreza, (2001), Erner *et al.*, (2002) and Dircen Mattos *et al.*, (2010).

Conclusion

The highest navel orange yield and best fruit qualities may be obtained under the similar environment and soil conditions of this experiment and mature trees from the fertilization regime of 1485gN + 304.5gP+ 1200gK + 50gS + 7.5 g Mg + a mixture of 300, 150, 100, 50 and 50 mg kg^{-1} of applied fertilizer from chelaeted Fe, Mn, Zn, cu and B, respectively splitted into 6 doses in mid Mar, April, May, June, July, and August.

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تأثير تجزيىء السماد المتوازن على محصول البرتقال أبو سرة وجودة ثماره

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استخدم ثلاث مستويات من السماد المتوازن م١ (٤٩٥ جم ن + ١٠١.٥ جم فو + ٤٠٠ جم بو+ ٥٠ جم كب+ ٢.٥ جم مغ+ مخلوط من العناصر الصغرى مكون من ٣٠٠ و ١٥٠ و ١٠٠ و ٥٠و ٥٠ جزء من المليون من عناصر الحديد والمنجنيز والزنك و النحاس فى صورة مخلبية والبورون فى صورة حامض بوريك) والمستوى الثاني م٢ (٩٩٠ جم ن + ٢٠٣ جم فو + ٨٠٠ جم بو + ٥٠ جم كب + ٥ جم مغ + مخلوط العناصر الصغرى كما فى المستوى الأول) والمستوى الثالث م٣ (١٤٨٥ جم ن + ٣٠٤.٥ جم فو + ١٢٠٠ جم بو + ٥٠ جم كب + ٧.٥ جم. وذلك مقارنة بمعاملة المزارع (٤٩٥ جم ن + ١٠١.٥ جم فو للشجرة فى الموسم). وقد تم إضافة الثلاث مستويات من السماد فى أربع معاملات تجزئة:

١-إضافته على ثلاث دفعات شهرية تبدأ من منتصف مارس.

٢-إضافته على ست دفعات شهرية تبدأ من منتصف مارس.

٣-إضافته على تسع دفعات نصف شهرية تبدأ من منتصف مارس.

٤-إضافته علي اثنتى عشرة دفعة نصف شهرية تبدأ من منتصف مارس.

وذلك لأشجار البرتقال أبو سرة المثمرة الناضجة بمركز مطوبس محافظة كفرالشيخ خلال الموسمين ٢٠٠٨/٢٠٠٧، ٢٠٠٩/٢٠٠٨ فى تصميم قطاعات تامة العشوائية فى أربع مكررات بحيث تمثل الشجرة وحدة تجريبية لدراسة أثر هذه المعاملات على إنتاجية البرتقال أيو سرة وجودة ثماره ويمكن تلخيص النتائج فى الآتى:

أعطى مستوى السماد المتوازن الثالث (م٣) أعلى قيمة لكلورفيل أ (٨٩.٩ و ٩٤.١ ميكروجرام/ سم٢) وكلوروفيل ب (٧١.٨ و ٧٥.٧ ميكروجرام/ سم٢) وكلوروفيل كلى (١٦١.٧ و ١٦٩.٨ ميكروجرام/ سم٢) ونيتروجين كلى فى الأوراق (٢.٦٢%) وفوسفور كلى فى الأوراق (٠.٠٥٤ و ٠.٠٥٧%) وبوتاسيوم كلى (١.٦٧ و ١.٦٢%) ونسبة عقد للثمار (٦.٤%) ومحصول للثمار (١٣٨.٢ و ١٣٣.٥ كجم/ شجرة) والجوامد الكلية (١١.٥ و ١١.٨%) والحموضة (٠.٩٨ و ٠.٩٧%) وفيتامين ج (٥٧.٨ و ٥٦.٧ مليجرام كل ١٠٠ مل من العصير) والسكريات المختزلة (٤.٢%) والسكريات الكلية (٧.٤ و ٧.٣%) فى الموسمين الأول والثاني على التوالي.

بينما رافق هذا المستوى من التسميد المتوازن م٣ أقل تساقط قبل الحصاد (٧.١ و ٦.٦%) في الموسم الأول والثاني على التوالي وعلى العكس كانت أقل قيمة للقياسات السابقة مع معاملة المزارع كما كانت أعلى القيم في القياسات السابقة ناتجة عن تجزئي السماد المتوازن إلى ست دفعات مقارنة بمعاملات التجزيئ الأخرى في الموسمين.

قام بتحكيم البحث

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Table 2: Effect of balanced fertilizer splitting on leaf chlorophyll and N, P and K% of Navel orange in 2007/ 2008 and 2008/2009 seasons

Treatments		**Chlorophyll A (µg/ cm^2)**		**Chlorophyll B (µg/ cm^2)**		**Total chlorophyll (µg/ cm^2)**		**N%**		**P%**		**K%**	
Levels /	**split**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**
Control		68.0 G	71.0 E	55.2 H	55.4 H	123.2 I	126.4J	2.5ABC	2.3 C	0 0.043A	0.043AB	1.18DEFG	1. 24
L_1	3 doses	8 83.3DE	88.4C	71.6 B	70.2CD	154.9 DE	158.5F	2.33BC	2.07D	0.052A	0.046AB	1.15EFG	1.30D
L_2		87.9BC	91.7B	67.5DE	71.6C	155.3DE	163.2D	2.71AB	2.47BC	0.050A	0.042B	1.34CDE	1.32D
L_3		9 90.9AB	94.6A	71.9B	76.5B	162.8B	171.1B	2 2.57ABC	2.63AB	0.043A	0.047AB	1.36CD	1.31D
Mean		87.4	91.6	70.3	72.8	157.7	164.3	2.54	2.4	0.048	0.045	1.28	1.31
L_1	6 doses	86.2CD	87.3C	65.5EF	70.6CD	151.7F	157.9F	2.23C	2.47BC	0.051A	0.050AB	1.13FG	1.05E
L_2		88.6BC	91.8B	68.6CD	71.2CD	157.2D	163.0D	2.52ABC	2.61AB	0.046A	0.045AB	1.24DEFG	1.42D
L_3		92.5 A	95. A	76.6A	81.4A	169.1A	176.3A	2.8A	2.75A	0.054	0.06A	1.92A	1.84A
Mean		89.1	91.4	70.2	74.4	159.3	165.7	2.46	2.61	0.050	0.051	1.43	1.44
L_1	9 doses	80.4 E	87.7C	61.9G	65.3FG	142.3H	153.0H	2.6ABC	2.6AB	0.06A	0.04B	1.45BC	1.43CD
L_2		83.1DE	92.2B	70.6BC	68.6DE	153.7EF	160.8E	2.6ABC	2.6AB	0.04A	0.05AB	1.47BC	1.42D
L_3		88.8BC	95.3A	71.5B	72.3C	160.3C	167.6C	2.8A	2.6AB	0.06A	0.06A	1.8A	1.6BC
Mean		84.1	91.7	68.0	68.7	152.1	160.5	2.7	2.6	0.05	0.05	1.57	1.48
L_1	12 doses	77.3 F	82.1D	64.4F	63.3G	141.7H	145.4I	2.4ABC	2.4BC	0.05A	0.05AB	1.1G	1.31D
L_2		82.4 E	88.6C	65.3EF	66.3EF	147.6G	154.9G	2.5ABC	2.5ABC	0.05A	0.05AB	1.3CDEF	1.27D
L_3		87.3 C	91.6B	67.3DE	72.6C	154.6DE	164.2D	2.5ABC	2.5ABC	0.06A	0.06AB	1.59B	1.71AB
Mean		82.3	87.4	65.7	67.4	147.9	154.8	2.5	2.5	0.05	0.05	1.33	1.43
Mean L_1		81.8	86.4	65.9	67.4	147.7	153.7	2.39	2.39	0.053	0.047	1.21	1.27
Mean L_2		85.5	91.2	68.0	69.4	153.5	160.5	2.58	2.55	0.047	0.047	1.34	1.36
Mean L_3		89.9	94.1	71.8	75.7	161.7	169.8	2.62	2.62	0.054	0.057	1.67	1.62

Table 3: Effect of balanced fertilizer splitting on yield and fruit physical properties of navel orange in 2007/ 2008 and 2008/2009 seasons

Treatment		Fruit set%		Pre-harvest fruit drop%		Fruit weight (g)		Fruit number tree^{-1}		Yield (kg tree^{-1})	
Levels/split		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control		5.1 B	5.3 D	9.1 A	9.9 A	276.0 AB	263.0 AB	470.7 C	457.7C	129.0D	120.1D
L_1	3 doses	6.3AB	5.6CD	6.8BC	7.2D	251.3BCD	244.4A3	519.7AB	499.3B	130.5D	121.7D
L_2		5.8AB	6.3C	7.1BC	7. 11D	251.2BCD	239.8B	521.7AB	543.7AB	130.4D	122.3D
L_3		6.3AB	6.4BC	7.0BC	6.0EF	243.9CD	246.1AB	517.3B	509.7AB	136.2D	125.5CD
Mean		6.1	6.1	7.0	6.8	248.8	243.4	519.6	517.6	129.0	123.2
L_1	6 doses	5.4B	6.0CD	7.9AB	7.3D	257.7BCD	255.8AB	522.3AB	510.7AB	134.5CD	130.5BCD
L_2		7.1A	7.2AB	7.4BC	6.9DE	290.4A	271.9A	538.7AB	522.7AB	146.4B	141.1A
L_3		7.2A	7.4A	6.1C	5.5F	266.1BC	261.5AB	557.3AB	546.0A	148.3A	142.4A
Mean		6.6	6.9	7.0	6.6	271.4	263.1	539.4	526.5	146.4	138.0
L_1	9 doses	5.6B	5.3D	7.2BC	7.6CD	236.2D	244.2AB	559.3A	522.3AB	132.0D	127.3BCD
L_2		5.9AB	5.5CD	7.4BC	7.3D	241.1CD	246.8AB	556.3AB	521.0AB	134.1CD	128.6BCD
L_3		5.6B	5.8CD	7.6ABC	7.66CD	242.3CD	254.1AB	550.3AB	511.7AB	133.0CD	130.0BCD
Mean		5.7	5.5	7.4	7.5	239.9	248.4	555.3	518.3	133.0	128.6
L_1	12 doses	5.5B	5.5CD	8.3AB	8.8B	251.1BCD	251.4AB	530.3AB	517.7AB	133.1CD	129.8BCD
L_2		5.2B	5.0CD	8.2AB	8.5BC	261.7BCD	273.1A	539.3AB	502.0AB	141.0BC	137.1AB
L_3		6.5AB	6.1CD	7.6ABC	7.3D	261.0BCD	262.8AB	542.3AB	517.7AB	141.2BC	135.9ABC
Mean		5.7	5.5	8:0	8.2	257.9	262.4	537.3	512.5	138.4	134.3
Mean L_1		5.8	5.6	7.6	7.7	249.1	249.0	532.9	512.5	132.5	127.3
Mean L_2		6.0	6.0	7.5	7.5	249.0	257.9	539.0	522.4	137.9	132.3
Mean L_3		6.4	6.4	7.1	6.6	253.3	256.1	541.8	521.3	138.2	133.5

Table 4: Effect of balanced fertilizer splitting on fruit chemical properties of navel orange in 2007 – 2008 and 2008-2009 seasons

Treatment		SSC%		Acidity %		V.C mg/100 mL Juice		Reducing sugars %		Non-reducing sugars %		Total sugars %	
Level/split		1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
Control		9.9D.E.F	10.0F.G	0.92F	0.91F	51.9E	51.5EF	3.8BC	3.6CD	2.5C	2.6D	6.3E	6.2D
L1	3 doses	10.8BCD	10.3F	0.95DE	0.94DE	53.5CDE	52.8CDEF	3.7BC	3.6CD	3.1AB	3.4AB	6.8D	7.0B
L2		10.9BCD	11.0DE	0.97BC	0.95CD	56.2B	54.3BCD	3.8BC	4.0BCD	3.5A	3.2ABCD	7.3BC	7.1AB
L3		11.3B	12.4AB	0.99A	0.98AB	59.3A	58.3A	4.2AB	4.3AB	3.6AB	2.9ABCD	7.3BC	7.2AB
Mean		11.0	11.2	0.97	0.96	56.3	55.1	3.9	4.0	3.4	2.2	7.1	7.1
L1	6 doses	11.4B	10.5EF	0.97BC	0.96BC	55.1BCD	53.5BCDE	3.7BC	3.7CD	3.2A	2.9ABCD	6.9D	6.6C
L2		10.9BC	11.5CD	0.99AB	0.98AB	57.4AB	55.3B	3.9BC	3.6CD	3.4A	3.1ABCD	7.3BC	7.0B
L3		12.4A	12.8A	1.0A	0.99A	59.5A	60.1A	4.5A	4.7A	3.3A	2.8BCD	7.8A	7.5A
Mean		11.6	11.6	0.99	0.98	57.3	56.3	4.0	4.0	3.3	2.9	7.3	7.0
L1	9 doses	10.0CDEF	10.1FG	0.99EF	0.91F	52.1E	51.9DEF	3.7BC	3.5CD	2.6C	2.8CD	6.31E	6.2D
L2		10.1CDEF	10.1FG	0.95CD	0.92F	53.4DE	52.5CDEF	3.6C	3.3D	2.8BC	3.3ABC	6.3E	6.6C
L3		11.5B	12.0BC	0.96CD	0.95CD	56.4B	54.9BC	4.0ABC	4.1ABC	3.4A	3.0ABCD	7.4B	7.1AB
Mean		10.5	10.7	0.97	0.93	54.0	53.1	3.8	3.6	2.9	3.0	6.7	6.6
L1	12 doses	9.6F	9.5G	0.93F	0.91F	52.1E	50.7F	3.5C	3.3D	2.7C	2.8BCD	6.2E	6.1D
L2		9.8EF	9.9FG	0.95DE	0.93EF	52.1E	52.4CDEF	3.7BC	3.4D	2.7C	2.8CD	6.3E	6.1D
L3		10.6BCDE	10.1FG	0.95DE	0.94DE	55.9BC	53.6BCDE	3.9BC	3.6CD	3.2A	3.4A	7.1CD	7.2AB
Mean		10.0	9.8	0.94	0.93	53.4	52.2	3.7	3.4	2.9	3.0	6.5	6.5
Mean L1		10.5	10.1	0.96	0.93	53.2	52.2	3.7	3.5	2.9	3.0	6.6	6.5
Mean L2		10.4	10.6	0.97	0.95	54.8	53.6	3.8	3.6	3.1	3.1	6.8	6.7
Mean L3		11.5	11.8	0.98	0.97	57.8	56.7	4.2	4.2	3.3	3.0	7.4	7.3