Assiut J. Agric. Sci., (48) No. (3) 2017 (172-187) *ISSN: 1110-0486*
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Effect of Some Organic N Fertilizers Enriched with *Spiruling Platensis* Algae on Growth and Productivity of Red Roomy Grapevines

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Received on: 20/3/2017 **Accepted for publication on:** 27/3/2017

Abstract

During 2015 and 2016 seasons, Red Roomy grapevines were fertilized with three organic manures (Poultry manure, Plant compost and Farmyard manure) enriched with *Spirulina platensis* algae as a partial replacement of 25 to 75% inorganic N. The merit was detecting the best source of organic N enriched with *Spirulina platensis* algae applied with inorganic N that responsible for producing higher yield with better berries quality.

Replacing 50% of inorganic N by 50% organic manures enriched with *Spirulina platensis* algae at 20 ml/vine was enhancing growth, yield and cluster weight on the other hand replacing 75% of inorganic N by 75% organic manures enriched with *Spirulina platensis* algae at 40 ml/vine gave favourable effects on vine nutritional status, berries colouration and quality of the grapes. Percentage of shot berries was greatly declined by using N as 25% inorganic N plus 75% organic manures enriched with *Spirulina platensis* algae at 40 ml/vine. In descending order, the best organic manures in this respect were poultry manure, Plant compost and Farmyard manure.

For enhancing growth and yield of Red Roomy grapevines, it is suggested to supply the vines with N (60g/vine/year) through 50% inorganic N + 50% poultry manure enriched with *Spirulina platensis* algae at 20 ml/vine/year. Fertilizing the vines with N as 25% inorganic N + 75% poultry manure enriched with 40 ml *Spirulina platensis* algae gave the best results with regard to berries colouration and quality.

Keywords: *Organic N, Inorganic N, Spirulina platensis algae, Red Roomy grapevines, yield, fruit quality.*

Introduction

Adjusting inorganic N fertilizers by using organic manures enriched with *Spirulina platensis* algae is necessary for controlling shot berries, improving yield, berries colouration and quality of the berries in grapevine cv. Red Roomy.

Spirulina platensis algae contains polysaturated fatty acids, plant pigments, proteins, amino acids, vitamin A, vitamin B, lipids, carbohydrates and sugars (Koru, 2009 and Henrikson, 2010).

Previous studies showed that using organic manures enriched with different microorganisms as a partial replacement of inorganic N was useful for improving yield and quality of berries in various grapevine cvs (Abada, 2009; Madian, 2010; Refaai, 2011; El-Wany, 2015; Aly-Samar, 2015; Motawea, 2016 and Tony, 2016).

The target of this study was examining the effect of replacing inorganic N fertilizers partially by different organic manures enriched with *Spirulina platensis* algae on yield and fruit quality of Red Roomy grapevines.

Material and Methods

This study was carried out during 2015 and 2016 seasons on thirty grapevine uniform in vigour 10-years old Red Roomy grown in a private vineyard located at Abu-Korkas district, Minia Governorate where the texture of the soil is clay, well drained and water table not less than two meters deep. All the selected vines are planted at 2 × 2 m apart. The chosen vines (30 vines) were head pruned during the middle of January in both seasons using spur pruning method. Vine bud load was 72 eyes for all the selected vines on the basis of 20 fruiting spurs × 3 eyes plus 6 replacement spurs × two eyes. Surface irrigation system was followed using Nile water containing 160 ppm EC.

Except those dealing with the present treatments (all sources of N), all the selected vines received the usual horticultural practices which are commonly used in the vineyard.

This study included the following ten treatments from inorganic N, organic manures and *Spirulina platensis* algae:

1. Application of the recommended N (60 g N/ vine/ year) via 100 % inorganic N (179.0 g ammonium nitrate / vine / year) alone.
2. Application of the recommended N via 75 % Inorganic N (134.3 g ammonium nitrate / vine / year) + 25% plant compost (2.0 % N) (0.75 kg /vine /year) + 10 ml *Spirulina platensis* algea / vine / year.
3. Application of the recommended N via 75 % + 25 % farmyard manure (0.25 % N) (6 kg / vine/ year) + 10 ml *Spirulina platensis* algae /vine / year.
4. Application of the recommended N via 75 % inorganic N + 25% poultry manure (2.5 % N) (0.6 kg/ vine / year) + 10 ml *Spirulina platensis* algae / vine / year.
5. Application of the recommended N via 50 % inorganic N (89.5 g ammonium nitrate / vine/ year) + 50 % plant compost (1.5 kg/ vine/ year) + 20 ml *Spirulina platensis* algae / vine/ year.
6. Application of the recommended N via 50 % inorganic N + 50 % farmyard manure (12 kg/ vine/ year) + 20 ml *Spirulina platensis* algae / vine/ year.
7. Application of the recommended N via 50 % inorganic N + 50 % poultry manure (1.2 kg/ vine/ year) + 20 ml *Spirulina platensis* algae / vine/ year.
8. Application of the recommended N via 25 % inorganic N (44.8 g ammonium nitrate / vine/ year) + 75% plant compost (2.25 kg / vine/ year) + 40 *Spirulina platensis* algae / vine/ year.
9. Application of the recommended N via 25 % inorganic N + 75% farmyard manures (18 kg / vine/ year) + 40 ml *Spirulina platensis* algae / vine/ year.
10. Application of the recommended N via 25% inorganic N + 75% poultry manure (1.8 kg / vine/ year) + 40 ml *Spirulina platensis* algae / vine/ year.

Ammonium nitrate (33.5 % N) as a source of inorganic N was divided into three unequal batches as 45% at growth start (1st week of March), 20% before blooming (1st week of April) and 35% just after berry setting (3rd week of April). *Spirulina platensis* algae was added once before growth start (1st week of March) in shallow holes 20 cm apart from the trunk and covered with moist soil. The three organic manures were added once just after winter pruning (3rd week of January) 20 cm *Spirulina platensis* algae from the vine trunk in drenches (50 × 50 × 50 cm dimensions). Analyses of the three organic manures are given in Tables (1&2&3&4&5).

Table 1. Analysis of the tested soil

Constituents	Values
Particle size distribution:	
Sand %	7.0
Silt %	21.5
Clay %	71.5
Texture	Clay
pH(1:2.5 extract)	7.95
EC (1 :2.5 extract) (dsm^{-1}) 1 cm / 25°C.	0.97
O.M. %	2.01
$CaCO_3$ %	2.41
Total N %	0.11
Available P (Olsen, ppm)	3.11
Available K (ammonium acetate, ppm)	405.9

During both seasons, the following measurements were recorded:

1. Growth aspects namely main shoot length (cm), number of leaves/shoot, leaf area (Ahmed and Morsy, 1999), wood ripening coefficient (Bouard, 1966) and cane thickness (cm).
2. Leaf chemical components namely chlorophylls a, b, total chlorophylls, total carotenoids (mg/100 g F.W) (von- Wettstein, 1979) and (Fadle and Seri El-Deen, 1978), N, P, K, Mg, Ca, S, Fe, Mn and Cu (Wilde *et al.* 1985 and Balo *et al.,* 1988) and total carbohydrates (A.O.A.C, 2000).
3. Berry setting %, yield weight and clusters number /vine, cluster weight andits dimensions.
4. Percentages of shot berries and berries colouration.
5. Physical and chemical characteristics of the berries namely weight, length and diameter, T.S.S., total acidity%, reducing sugars% (A.O.A.C, 2000) and total anthocyanins (Fulki and Francis, 1968).

Statistical analysis was done using new L.S.D. at 5% (according to Mead *et al*., 1993 and Rao, 2007). Randomized complete block design (RCBD) was followed (Rangaswamy, 1995), where the experiment consisted of ten treatments, each treatment was replicated three times, one vine per each.

Results and Discussion

1- Some vegetative growth characteristics:

It is clear from the obtained data in Table (6) that the five growth characteristics namely main shoot length, number of leaves/shoot, leaf area, wood ripening coefficient and cane thickness were significantly affected with the ten nitrogen management treatments. Under organic and biofertilization conditions, reducing the percentages of inorganic N from 75 to 50% of the recommended N caused a gradual stimulation on these growth characteristics. Generally, using the recommended N via inorganic N at 50 to 75% besides organic and biofertilization with any of the three organic manures at 25 to 50% and *Spirulina platensis* algae at 10 to 20 ml / vine / year significantly stimulated all growth characteristics rather than using inorganic N at 100% or when inorganic N was added as 25% with organic and biofertilization. The promotion on such growth aspects was significantly associated with reducing the percentages of inorganic N from 75 to 50% and at the same time increasing levels of both organic manures from 25 to 50% and *Spirulina platensis* algae from 10 to 20 ml/ vine. Using the recommended N via 25 % inorganic N under organic and biofertilization with any of the three organic manures and *Spirulina platensis* algae at 40 ml/ vine significantly reduced these growth characteristics comparing with using inorganic N at 50 to 75% plus using organic and biofertilization or when N was completely as inorganic N. The best organic manures in this respect were poultry manure, plant compost and farmyard manure, in descending order. The maximum values of main shoot length (122.3 and 123.7 cm), leaf area (103.0 & 104.1 cm^2), wood ripening coefficient (0.91 & 0.89), number of leaves/shoot (25.0 & 27.0) and cane thickness (1.32 & 1.35 mm) were recorded on the vines that were fertilized with N as 50% inorganic N + 50% poultry manure + 20 ml *Spirulina platensis* algae / vine duing both seasons, respectively. Fertilizing Red Roomy grapevines with N as 25% inorganic N plus application of farmyard manure at 75% and *Spirulina platensis* algae at 40 ml/ vine/ year gave the minimum values of main shoot length (101.6 & 103.0 cm), leaf area (86.9 & 88.0 cm^2), number of leaves/shoot (15.0 & 16.0), wood ripening coefficient (0.60 & 0.59 kg.) and cane thickness (0.81 & 0.84 cm) in both seasons, respectively. These results were true during both seasons.

2- Leaf pigments and total carbohydrates.

The obtained data in Table (7) showed that varying percentages of inorganic N and organic manures and levels of *Spirulina platensis* algae caused a significant effect on chlorophylls a & b, total chlorophylls, total carotenoids and total carbohydrates. Supplying the vines with N as 25 to 75% inorganic N plus any one of the three organic manures namely plant compost, farmyard manure and poultry manure each at 25-75% enriched with *Spirulina platensis* algae at 10 to 40 ml/ vine/ year significantly enhanced chlorophylls a & b, total chlorophylls, total carotenoids and total carbohydrates comparing with using N as 100% inorganic N. The promotion on the leaf pigments was significantly proportional to the reduction in the percentages of inorganic N from 100 to 25% and at the same time increasing percentages of organic manures from 0.0 to 75% and the levels of *Spirulina platensis* algae from 0 to

40 ml vine/ year. The best organic manures in enhancing these plant pigments and total carbohydrates from statistical point of view were poultry manure, plant compost and farmyard manure, in descending order.

The maximum values of chlorophylls a (7.8 & 7.7 mg/ 100 g. F.W.), b (3.2 & 4.0 mg/ 100 g. F.W.), total chlorophylls (11.0 & 11.7 mg/ 100 g. F.W.), total carotenoids (3.2 & 3.6 mg/ 100 g. F.W.) and total carbohydrates (17.0 & 17.3%) were recorded on the vines that were supplied with N as 25% inorganic + 75% poultry manure + 40 ml *Spirulina platensis* algae / vine/ year. The vines that received N as 100% inorganic gave the lowest values. These results were true during both seasons.

3- The percentages of N, P, K, Mg, S and Ca and Zn, Fe, Mn and Cu (as ppm) in the leaves.

It is evident from the obtained data in Tables (8 & 9) that varying N management had significant effect on the contents of N, P, K, Mg, S, Ca, Zn, Fe, Mn, Zn and Cu in the leaves. Fertilizing the vines with N through 25 to 75% inorganic N + any one of the three organic manures (poultry manure, plant compost and farmyard manure) each at 25 to 75% + *Spirulina platensis* algae at 10 to 40 ml/ vine/ year was significantly accompanied with enhancing these nutrients over the application of N as 100% inorganic N. There was a significant and gradual promotion on these nutrients (N, P, K, Mg, S, Ca, Zn, Fe, Mn and Cu) in the leaves with reducing the percentages inorganic N from 100 to 25% and at the same time increasing the percentages of organic manures from 0.0 to 75% and levels of *Spirulina platensis* algae for each vine from 0.0 to 40 ml. Supplying the vines with organic manure namely poultry manure, plant compost and farmyard manure each at 25 to 75% of N, in descending order, was significantly responsible for enhancing these nutrients. The highest values of N (2.36 & 2.27 %), P (0.40 & 0.38 %), K (1.59 & 1.62%), Mg (0.84 & 0.85%), S (0.94 & 0.99%), Ca (2.91 & 2.90%), Zn (69.4 & 72.9ppm), Fe (76.2 & 76.3ppm), Mn (75 & 76 ppm) and Cu (3.0 & 3.3ppm) were recorded on the vines that were supplied with N as 25% inorganic + 75% poultry manure + 40 ml *Spirulina platensis* algae / vine/ year. The vines that were fertilized with N completely via inorganic form gave the lowest values. Similar results were announced during both seasons.

4- Berry setting, yield and cluster characteristics:

It is revealed from the obtained data in Tables (10 & 11) that all inorganic N, organic manures and *Spirulina platensis* algae treatments had significant effects on the berry setting %, yield, number of clusters per vine as well as cluster weight and dimensions (length & shoulder). Supplying the vines with N as 50 to 75% inorganic N + 25 to 50% organic manures + 10 to 20 ml *Spirulina platensis* algae / vine/ year significantly improved these parameters comparing to using N completely via inorganic N or when inorganic N was applied at 25% + 75% organic manures (poultry manure, plant compost or farmyard manure) enriched with *Spirulina platensis* algae at 40 ml / vine/ year. The best organic manures in improving berry setting %, yield and cluster characteristics were poultry manure, plant compost and farmyard manure, in descending order. Using N as 100% inorganic N significantly was favourable than using N as 25% inorganic with organic and biofertilization in this respect. A significant decline on berry setting %, yield and cluster characteristics was observed when the percentage of inorganic N was lowered to 25% even with the application of organic manures at 75% and *Spirulina platensis* algae at 40 ml / vine/ year. There was a gradual and significant promotion on these characteristics with reducing the percentages of inorganic N from 100 to 50% and at the same time increasing the percentages of organic manures from 0.0 to 50% and the levels of *Spirulina platensis* algae from 0.0 to 20 ml / vine / year. The maximum berry setting (9.0 & 9.6 %), yield / vine (10.1 & 14.1 kg) and cluster weight (389.0 and 392.0) during both seasons, respectively were recorded on the vines that received N as 50% inorganic N + 50% poultry manure + 20 ml EM/ vine / year. The lowest values of berry setting (4.0 & 4.6 %) ; yield/ vine (7.5 & 7.9 kg) and cluster weight (301.0 & 304.0 g) during both seasons, respectively were observed on the vines that were fertilized with N as 25% inorganic + 75 % farmyard manure + 40 ml *Spirulina platensis* algae / vine/ year. The yield of the vines that were fertilized with N as 100% inorganic N reached 8.6 and 10.6 kg during both seasons, respectively. The percentage of increment on the yield due to using the previous promised treatment (50 % inorganic + 50% poultry manure + 20 ml *Spirulina platensis* algae / vine) over the check treatment (application of N as 100% inorganic N) reached 17.4 and 41.0% during both seasons, respectively. These results were true during both seasons.

5- Shot berries and berries colouration and quality of the berries.

It is obvious from the obtained data in Tables (11 & 12) that supplying the vines with N as 25 to 75% inorganic + 25 to 75% organic manures + 10 to 40 ml *Spirulina platensis* algae / vine/ year was significantly accompanied with reducing the percentage of shot berries and improving berries colouration % and fruit quality in terms of increasing weight, longitudinal and equatorial of berry, T.S.S. % and reducing sugars % and total anthcoyanins and decreasing total acidity % comparing with using N as 100% inorganic N. The promotion on berries colouration and fruit quality and the reduction on shot berries % were significantly related to reducing the percentages of inorganic N from 100 to 25% and at the same time increasing the percentages of organic manures from 0.0 to 75% and the levels of *Spirulina platensis* algea from 0.0 to 40 ml /vine/ year. The best organic manures in this respect were poultry manure, plant compost and farmyard manure, in descending order. Inorganic fertilization alone gave unfavourable effects on shot berries, berries colouration and quality of the berries. The best results with regard to the reduction shot berries and the promotion on berries colouration and fruit quality were obtained due to treating the vines with N as 25% inorganic N + 75% poultry manure + 40 ml *Spirulina platensis* algea / vine/ year. Percentage of shot berries in the berries reached the minimum values (2.6 and 2.1%) during both seasons, respectively when the vines were treated with N as 25% inorganic N + 75% poultry manure + 40 ml *Spirulina platensis* algea / vine/ year. These results were true during both seasons.

Discussion:

The previous promoting actions of organic fertilization combined with biofertilization using blue algae (*Spirulina platensis*) as a partial replacement of mineral N fertilizers on vine nutritional status, yield and fruit quality of Superior grapevines can be attributed to the positive role played by these aforementioned microorganisms in providing essential nutrients required for optimization of plant growth (Koru, 2009 and Henrikson, 2010), and their essential roles in soil fertility as they improve the biological, physical and chemical properties of the soil. On the other hand, *Spirulina platensis* is especially rich in nutrients and growth promoting constituents including amino acids antioxidants and vitamins (Koru *et al.,* 2008; Koru, 2009 and Henrikosn, 2010).

In addition, organic fertilization plays an important role in improving the soil condition and decreasing mineral N fertilizer toxic effects. Moreover, organic fertilization (by plant compost in the current study) is known to reduce soil-borne pathogens, problems of salinity, soil pH, leaching process and soil erosion and enhancing the production of growth promoting substances i.e. IAA, GA_3 and cytokinins, which in turn improve root development. Together with biofertilization, plant compost should increase nutrients availability and uptake, soil organic matter and microbial activity, soil aggregation and aeration, permeability of soil and water holding capacity. Moreover, these organic and biofertilizers are known to enhance nutrient transport, photosynthesis process, fixation of N, water uptake, vitamins B, solubility of most nutrients, soil workability, resistance to drought, buffering property of the soil, formation of heavy metal complexes, breaking of hazard chemicals, formation of hummus, tolerance to drought and temperature extremes, oxidation of sulphur complexes and converting insoluble sulphur to soluble one (Simon *et al,* 1999 and Chen *et al,* 2004).

These beneficial effects of organic and biofertilization surely reflected on enhancing growth characteristics, soil fertility, plant pigments and vine nutritional status consequently caused enhancement on fruiting status. Moreover, the increase in berry setting, number of clusters per vine and cluster weight resulted from these biostimulants surely reflected on improving the yield/vine. The great promotion on the biosynthesis and translocation of carbohydrates due to using these amendments could result in advancing maturity and improving quality of the berries.

In addition, the great control on the uptake of N by the vines due to using organic and biofertilization surely reflected on reducing the accumulation of both nitrites and nitrates in the berries. Thus, the application of these results would lower environmental pollution.

The results of this study are in agreement with those of previous studies that emphasized beneficial effects of organic and biofertilization in promoting yield and fruit quality in various grapevine cvs (Refaai, 2011; Aly-Samar, 2015; El-Wany, 2015 and Motawea, 2016).

In addition, the findings of the recent studies provide further support for the results of this study. Both fruiting and berry quality aspects were improved in response to biofertilization and/or organic fertilization in comparison to inorganic fertilization alone as previously reported by Madian (2010) and Refaai (2011).

The results regarding the promoting effect of organic manures and biofertilization on growth vine nutritional status, yield and berries quality are in harmony with those obtained by Refaai (2011) and Uwakiem (2011) grapevine cvs.

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تأثير بعض الأسمدة العضوية المزودة بطحلب الاسبيريولينا بلاتينسيس علي النمو وانتاجية العنب الرومى الأحمر

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الملخص

خلال موسمى ٢٠١٥، ٢٠١٦ تم تسميد كرمات العنب الرومى الأحمر بثلاثة مصادر عضوية (زرق الدواجن– كمبوست النبات – السماد البلدى) المزودة بطحلب الاسبيريولينا بلاتنسيس كبديل جزئى بنسبة ٢٥–٧٥% سماد نيتروجينى غير عضوى وكان الهدف بيان افضل مصدر ومعدل للتسميد النيتروجينى العضوى وطحلب الاسبيريولينا بلاتنسيس المستخدم مع السماد النيتروجينى الغير عضوى وذلك لانتاج محصول عالي وخصائص جودة عالية للحبات.

أدى استبدال ٥٠% من السماد النيترروجينى الغير عضوى بنسبة ٥٠% أسمدة عضوية مزودة بطحلب الاسبيريولينا بلاتنسيس بمعدل ٢٠ مل للكرمة/السنة إلي حدوث تحسن فى النمو وكمية المحصول ووزن العنقود أما استبدال ٧٥% من السماد النيتروجينى الغير عضوى بنسبة ٧٥% أسمدة عضوية مزودة بطحالب الاسبيريولينا بلاتنسيس بمعدل ٤٠ مل للكرمة/ السنة فقد كان فعالا فى تحسين الحالة الغذائية للكرمات، تلوين الحبات وجودة الحبات ولقد قلت النسبة المئوية للحبات الصغيرة كثيرا باستخدام النيتروجين علي أساس ٢٥% سماد غير عضوى + ٧٥% سماد عضوى مزودة بطحلب الاسبيريولينا بلاتنسيس بمعدل ٤٠ مل للكرمة وكان أفضل مصدر للسماد العضوى فى هذا الصدد هو سماد زرق الدواجن يليه كمبوست النبات ثم السماد البلدى مرتبة ترتيبا تنازليا.

لأجل تحسين النمو وكمية محصول كرمات العنب الرومى الأحمر فانه يقترح تسميد الكرمات بالنيتروجين (٦٠ جرام/السنة) خلال٥٠% سماد غير عضوى، ٥٠% سماد عضوى زرق الدواجن مع طحلب الاسبيريولينا بلاتنسيس بمعدل ٢٠ مل/الكرمة، أما تسميد الكرمات بالنيتروجين علي أساس ٢٥% سماد غير عضوى + ٧٥% سماد زرق الدواجن المزودة بـ ٤٠ مل من طحلب الاسبيريولينا بلاتنسيس فإنه يعطى أفضل النتائج بخصوص تلوين الحبات وجودتها.

الكلمات الدالة: *نيتروجين عضوى – نيتروجين غير عضوى – طحلب الاسبيريولينا بلاتنسيس – العنب الرومى الأحمر*

Table 6. Effect of some organic manures enriched with *Spirulina Platensis* algae on some vegetative growth characteristics of Red Roomy grapevines during 2015 and 2016 seasons.

Treatment	Main shoot length (cm.)		No. of leaves/shoot		Leaf area (cm.)		Wood ripening coefficient		Cane thickness (mm)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
N as 100% Inorg. N	107.7	109.0	18.0	19.0	91.9	93.0	0.69	0.67	0.97	1.00
N as 75 % Inorg. N + 25% P.C. + 10 ml S.P.	111.9	113.1	20.0	22.0	95.0	96.2	0.76	0.74	1.07	1.10
N as 75 % Inorg. N + 25 % F.Y.M. + 10 ml S.P	110.0	111.3	19.0	20.0	93.3	94.4	0.72	0.69	1.02	1.05
N as 75 % Inorg. N + 25% P.M. + 10 ml S.P	113.3	114.6	22.0	23.0	97.0	98.2	0.80	0.78	1.13	1.16
N as 50 % Inorg. N + 50 % P.C. + 20 ml S.P	118.9	120.2	24.0	25.0	101.3	102.4	0.88	0.86	1.26	1.30
N as 50 % Inorg. N + 50 % F.Y.M. + 20 ml S.P	115.0	115.4	23.0	24.0	98.3	99.5	0.85	0.83	1.20	1.23
N as 50 % Inorg. N + 50 % P.M. + 20 ml S.P	122.3	123.7	25.0	27.0	103.0	104.1	0.91	0.89	1.32	1.35
N as 25 % Inorg. N + 75 % P.C. + 40 ml S.P	103.3	104.6	16.0	17.0	88.3	89.5	0.63	0.61	0.86	0.90
N as 25 % Inorg. N + 75 % F.Y.M. + 40 ml S.P	101.6	103.0	15.0	16.0	86.9	88.0	0.60	0.59	0.81	0.84
N as 25 % Inorg. N + 75 % P.M. + 40 ml S.P	105.0	106.4	17.0	18.0	89.5	90.7	0.66	0.64	0.91	0.94
New L.S.D. at 5%	**1.0**	**1.1**	**1.0**	**1.0**	**1.0**	**1.1**	**0.03**	**0.03**	**0.04**	**0.04**

- P.C.= Plant compost (2.0 % N); F.Y.M.= Farmyard manure (0.25% N); P.M = Poultry manure (2 .5% N) and S.P.= *Spirulina platensis* algae

Table 7. Effect of some organic manures enriched with *Spirulina Platensis* algae on some leaf pigments and percentage of total carbohydras in the leaves of Red Roomy grapevines during 2015 and 2016 seasons.

Treatment	Chlorophyll a (mg/ 100 g F.W.)		Chlorophyll b (mg/ 100 g F.W.)		Total chlorophylls (mg/ 100 g F.W.)		Total carotenoids (mg/ 100 g F.W.)		Total carbohydrates (%)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
N as 100% Inorg. N	4.1	4.0	1.4	1.7	5.5	5.7	1.2	1.3	13.7	14.0
N as 75 % Inorg. N + 25% P.C. + 10 ml S.P.	4.8	4.7	1.8	2.2	6.6	6.9	1.6	1.7	14.4	14.7
N as 75 % Inorg. N + 25 % F.Y.M. + 10 ml S.P	4.4	4.3	1.6	2.0	6.0	6.3	1.4	1.5	14.1	14.3
N as 75 % Inorg. N + 25% P.M. + 10 ml S.P	5.2	5.1	2.0	2.5	7.2	7.6	1.8	2.0	14.8	15.1
N as 50 % Inorg. N + 50 % P.C. + 20 ml S.P	6.0	5.9	2.4	3.0	8.4	8.9	2.3	2.5	15.6	15.8
N as 50 % Inorg. N + 50 % F.Y.M. + 20 ml S.P	5.6	5.5	2.2	2.8	7.8	8.3	2.0	2.2	15.3	15.5
N as 50 % Inorg. N + 50 % P.M. + 20 ml S.P	6.4	6.3	2.5	3.3	8.9	9.6	2.5	2.8	16.0	16.1
N as 25 % Inorg. N + 75 % P.C. + 40 ml S.P	7.4	7.3	3.0	3.8	10.4	11.1	2.9	3.3	16.7	16.9
N as 25 % Inorg. N + 75 % F.Y.M. + 40 ml S.P	6.9	6.8	2.8	3.6	9.7	10.4	2.7	3.0	16.3	16.6
N as 25 % Inorg. N + 75 % P.M. + 40 ml S.P	7.8	7.7	3.2	4.0	11.0	11.7	3.2	3.6	17.0	17.3
New L.S.D. at 5%	**0.3**	**0.3**	**0.2**	**0.2**	**0.3**	**0.3**	**0.2**	**0.2**	**0.3**	**0.3**

- P.C.= Plant compost (2.0 % N); F.Y.M.= Farmyard manure (0.25% N); P.M = Poultry manure (2 .5% N) and S.P.= *Spirulina platensis* algae

Table 8. Effect of some organic manures enriched with *Spirulina Platensis* algae on percentages of N, P, K, Mg and Ca in the leaves of Red Roomy grapevines during 2015 and 2016 seasons.

Treatment	Leaf N %		Leaf P %		Leaf K %		Leaf Mg %		Leaf Ca %	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
N as 100% Inorg. N	1.61	1.67	0.14	0.15	1.11	1.15	0.49	0.52	2.11	2.01
N as 75 % Inorg. N + 25% P.C. + 10 ml S.P.	1.78	1.80	0.19	0.20	1.20	1.30	0.56	0.59	2.29	2.20
N as 75 % Inorg. N + 25 % F.Y.M. + 10 ml S.P	1.71	1.73	0.17	0.18	1.16	1.23	0.53	0.55	2.20	2.11
N as 75 % Inorg. N + 25% P.M. + 10 ml S.P	1.86	1.87	0.21	0.23	1.25	1.35	0.60	0.63	2.40	2.31
N as 50 % Inorg. N + 50 % P.C. + 20 ml S.P	2.00	2.00	0.27	0.28	1.38	1.45	0.67	0.71	2.58	2.49
N as 50 % Inorg. N + 50 % F.Y.M. + 20 ml S.P	1.94	1.94	0.23	0.25	1.31	1.39	0.63	0.67	2.50	2.41
N as 50 % Inorg. N + 50 % P.M. + 20 ml S.P	2.11	2.07	0.30	0.30	1.43	1.49	0.71	0.75	2.69	2.59
N as 25 % Inorg. N + 75 % P.C. + 40 ml S.P	2.28	2.20	0.37	0.35	1.54	1.58	0.80	0.82	2.89	2.80
N as 25 % Inorg. N + 75 % F.Y.M. + 40 ml S.P	2.20	2.12	0.33	0.33	1.50	1.53	0.75	0.78	2.79	2.70
N as 25 % Inorg. N + 75 % P.M. + 40 ml S.P	2.36	2.27	0.40	0.38	1.59	1.62	0.84	0.85	2.91	2.90
New L.S.D. at 5%	**0.06**	**0.05**	**0.02**	**0.02**	**0.04**	**0.04**	**0.03**	**0.03**	**0.07**	**0.06**

- P.C.= Plant compost (2.0 % N); F.Y.M.= Farmyard manure (0.25% N); P.M = Poultry manure (2 .5% N) and S.P.= *Spirulina platensis* algae

Table 9. **Effect of some organic manures enriched with *Spirulina Platensis* algae on the leaf content of S (as %) and Zn, Fe, Mn and Cu in the leaves of Red Roomy grapevines during 2015 and 2016 seasons.**

Treatment	Leaf S %		Leaf Zn (ppm)		Leaf Mn (ppm)		Leaf Fe (ppm)		Leaf Cu (ppm)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
N as 100% Inorg. N	0.59	0.64	51.0	51.9	55.3	56.9	56.9	57.0	0.9	1.1
N as 75 % Inorg. N + 25% P.C. + 10 ml S.P.	0.67	0.72	54.5	55.9	59.1	60.0	61.0	61.1	1.4	1.6
N as 75 % Inorg. N + 25 % F.Y.M. + 10 ml S.P	0.63	0.67	52.2	53.3	57.2	58.1	59.0	59.1	1.1	1.3
N as 75 % Inorg. N + 25% P.M. + 10 ml S.P	0.70	0.76	56.7	59.0	61.0	61.8	63.0	63.1	1.6	1.9
N as 50 % Inorg. N + 50 % P.C. + 20 ml S.P	0.77	0.85	60.3	64.0	65.1	66.0	68.0	68.2	2.0	2.5
N as 50 % Inorg. N + 50 % F.Y.M. + 20 ml S.P	0.74	0.81	58.0	61.5	63.0	63.9	65.3	65.4	1.8	2.2
N as 50 % Inorg. N + 50 % P.M. + 20 ml S.P	0.80	0.88	62.3	66.3	67.2	68.1	70.3	70.3	2.2	2.7
N as 25 % Inorg. N + 75 % P.C. + 40 ml S.P	0.88	0.96	67.0	70.6	71.9	73.0	74.0	73.9	2.7	3.1
N as 25 % Inorg. N + 75 % F.Y.M. + 40 ml S.P	0.84	0.92	64.7	68.4	69.3	70.3	71.9	72.0	2.5	2.9
N as 25 % Inorg. N + 75 % P.M. + 40 ml S.P	0.94	0.99	69.4	72.9	75.0	76.0	76.2	76.3	3.0	3.3
New L.S.D. at 5%	**0.03**	**0.03**	**2.0**	**2.1**	**1.9**	**1.8**	**1.9**	**1.9**	**0.2**	**0.2**

- P.C.= Plant compost (2.0 % N); F.Y.M.= Farmyard manure (0.25% N); P.M = Poultry manure (2.5% N) and S.P.= *Spirulina platensis* algae

Table 10. Effect of some organic manures enriched with *Spirulina Platensis* algae on the percentage of berry setting, yield as well as weight and shoulder of cluster of Red Roomy grapevines during 2015 and 2016 seasons.

Treatment	Berry Setting %		No. of clusters per vine		Yield/vine (kg.)		Cluster Weight (g.)		Cluster shoulder (cm)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
N as 100% Inorg. N	5.4	6.0	26.0	30.0	8.6	10.0	330.0	333.0	13.3	13.8
N as 75 % Inorg. N + 25% P.C. + 10 ml S.P.	6.6	7.2	26.0	32.0	9.1	11.3	350.0	352.5	13.9	14.5
N as 75 % Inorg. N + 25 % F.Y.M. + 10 ml S.P	5.9	6.5	26.0	31.0	8.8	10.6	340.0	342.5	13.6	14.2
N as 75 % Inorg. N + 25% P.M. + 10 ml S.P	7.2	7.8	26.0	33.0	9.4	12.0	360.0	363.0	14.2	14.8
N as 50 % Inorg. N + 50 % P.C. + 20 ml S.P	8.3	8.9	26.0	35.0	9.6	13.4	380.0	383.0	15.0	15.6
N as 50 % Inorg. N + 50 % F.Y.M. + 20 ml S.P	7.7	8.3	26.0	34.0	9.6	12.7	370.0	373.0	14.6	15.2
N as 50 % Inorg. N + 50 % P.M. + 20 ml S.P	9.0	9.6	26.0	36.0	10.1	14.1	389.0	392.0	15.5	16.1
N as 25 % Inorg. N + 75 % P.C. + 40 ml S.P	4.4	5.0	25.0	27.0	7.8	8.5	310.0	313.0	12.6	13.2
N as 25 % Inorg. N + 75 % F.Y.M. + 40 ml S.P	4.0	4.6	25.0	26.0	7.5	7.9	301.0	304.0	12.3	13.0
N as 25 % Inorg. N + 75 % P.M. + 40 ml S.P	4.8	5.4	25.0	28.0	8.0	9.0	320.0	323.0	13.0	13.6
New L.S.D. at 5%	**0.4**	**0.4**	**NS**	**1.0**	**0.3**	**0.3**	**9.0**	**9.0**	**0.3**	**0.3**

- P.C.= Plant compost (2.0 % N); F.Y.M.= Farmyard manure (0.25% N); P.M = Poultry manure (2 .5% N) and S.P.= *Spirulina platensis* algae

Table 11. Effect of some organic manures enriched with Spirulina Platensis on cluster length, percentages of shot berries and colouration and weight and longitudinal of berry of Red Roomy grapevines during 2015 and 2016 seasons.

Treatment	Cluster length (cm)		Shot berries %		Berries colouration %		Berry weight (g.)		Berry longitudinal (cm)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
N as 100% Inorg. N	19.5	20.1	7.9	7.4	54.1	56.0	4.88	5.00	2.12	2.16
N as 75 % Inorg. N + 25% P.C. + 10 ml S.P.	20.4	21.0	7.0	6.5	58.2	60.1	5.10	5.22	2.22	2.26
N as 75 % Inorg. N + 25 % F.Y.M. + 10 ml S.P	20.0	20.6	7.4	6.9	56.1	58.0	4.98	5.10	2.17	2.23
N as 75 % Inorg. N + 25% P.M. + 10 ml S.P	21.0	21.7	6.6	6.1	61.0	62.9	5.20	5.32	2.27	2.33
N as 50 % Inorg. N + 50 % P.C. + 20 ml S.P	21.9	22.5	5.6	5.1	67.9	69.9	5.41	5.53	2.40	2.47
N as 50 % Inorg. N + 50 % F.Y.M. + 20 ml S.P	21.5	22.2	6.2	5.7	64.9	66.8	5.31	5.43	2.33	2.40
N as 50 % Inorg. N + 50 % P.M. + 20 ml S.P	22.4	23.0	5.0	4.5	71.9	73.8	5.51	5.63	2.45	2.52
N as 25 % Inorg. N + 75 % P.C. + 40 ml S.P	18.5	19.1	3.1	2.6	76.9	78.8	5.74	5.86	2.60	2.67
N as 25 % Inorg. N + 75 % F.Y.M. + 40 ml S.P	18.1	18.8	4.0	3.5	74.0	75.9	5.63	5.75	2.52	2.59
N as 25 % Inorg. N + 75 % P.M. + 40 ml S.P	19.0	19.6	2.6	2.1	79.0	80.9	5.85	5.97	2.65	2.72
New L.S.D. at 5%	**0.3**	**0.3**	**0.3**	**0.3**	**0.9**	**0.9**	**0.07**	**0.08**	**0.04**	**0.04**

- P.C.= Plant compost (2.0 % N); F.Y.M.= Farmyard manure (0.25% N); P.M = Poultry manure (2 .5% N) and S.P.= *Spirulina platensis* algae

Table 12. Effect of some organic manures enriched with Spirulina Platensis algae on berry equatorial and some chemical characteristics of the berries of Red Roomy grapevines during 2015 and 2016 seasons.

Treatment	Berry equatorial (cm)		T.S.S. %		Total Acidity %		Total Sugars %		Total antho-cyanins (mg/100g F.W)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
N as 100% Inorg. N	1.71	1.80	17.9	18.1	0.715	0.713	15.1	15.4	18.0	18.3
N as 75 % Inorg. N + 25% P.C. + 10 ml S.P.	1.83	1.91	18.9	19.0	0.672	0.669	15.8	16.1	19.0	19.3
N as 75 % Inorg. N + 25 % F.Y.M. + 10 ml S.P	1.76	1.85	18.4	18.5	0.694	0.691	15.5	15.8	18.5	18.8
N as 75 % Inorg. N + 25% P.M. + 10 ml S.P	1.90	1.99	19.4	19.5	0.649	0.646	16.2	16.5	20.0	20.4
N as 50 % Inorg. N + 50 % P.C. + 20 ml S.P	2.02	2.11	20.4	20.5	0.608	0.604	17.0	17.3	21.4	21.8
N as 50 % Inorg. N + 50 % F.Y.M. + 20 ml S.P	1.97	2.07	19.9	20.0	0.629	0.626	16.6	16.9	20.6	21.0
N as 50 % Inorg. N + 50 % P.M. + 20 ml S.P	2.07	2.16	20.9	21.0	0.588	0.585	17.3	17.6	22.0	22.4
N as 25 % Inorg. N + 75 % P.C. + 40 ml S.P	2.21	2.30	21.8	21.9	0.541	0.538	18.0	18.3	23.2	23.8
N as 25 % Inorg. N + 75 % F.Y.M. + 40 ml S.P	2.14	2.23	21.4	21.5	0.561	0.557	17.6	18.0	22.5	23.0
N as 25 % Inorg. N + 75 % P.M. + 40 ml S.P	2.30	2.40	22.3	22.4	0.521	0.518	18.3	18.7	25.1	25.5
New L.S.D. at 5%	**0.04**	**0.04**	**0.04**	**0.03**	**0.017**	**0.016**	**0.3**	**0.3**	**0.4**	**0.4**

- P.C.= Plant compost (2.0 % N); F.Y.M.= Farmyard manure (0.25% N); P.M = Poultry manure (2 .5% N) and S.P.= *Spirulina platensis* algae