

## Using Plant Compost Enriched With *Spirulina Plantensis* Algae as a Substitute for Mineral N Fertilizer in Flame Seedless Vineyards

Farouk H. Abdelaziz<sup>1</sup>; Hamdy I.M. Ibrahim<sup>1</sup>; Mohamed , M.A.Abada<sup>2</sup>and Samar S.A. Hasan <sup>1</sup>

<sup>1</sup> Hort. Dept. Fac. of Agric. Minia Univ. Egypt

<sup>2</sup> Viticulture Dept. Hort. Res. Instit. ARC Giza, Egypt

[faissalfadel@yahoo.com](mailto:faissalfadel@yahoo.com)

**Abstract:** Flame seedless grapevines fertilized with N via mineral N as 25 to 100% either alone or in combination with plant compost at 25% to 75% of N plus the algae biofertilizer namely *Spirulina plantensis* at 40 to 160 ml/vine/year. This study was performed during 2013 and 2014 seasons as a trial for substituting mineral N partially with organic and biofertilization. Growth, vine nutritional status, yield and quality of the berries in response to the present treatments were investigated. Using mineral N along with plant compost enriched with algae was favourable than using mineral N alone in enhancing growth characters, vine nutritional status, yield and berries quality. Growth characters and yield were obviously reduced with application of mineral N below 50% of N even with the application of plant compost enriched with algae. Reducing mineral N percentages from 100 to 25% of the suitable N and at the same time increasing percentages of both plant compost from 25 to 75% and levels of algae from 40 to 160 ml / vine/ year resulted in a progressive promotion on chlorophylls a & b, total chlorophylls and total carotenoids and berries quality. Supplying Flame seedless grapevines with N via 50% inorganic N + 50 % plant compost enriched with 80 ml *Spirulina plantensis* vine / year was suggested to be beneficial for improving yield and quality of the berries.

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### 1. Introduction

A principal goal of organic farming is producing healthy fruits without the use of chemical fertilizers as well as protecting our environment from pollution. Achieving of this target was conducted through the use of organic and biofertilizers. These fertilizers have great advantages such as promoting soil fertility, availability of nutrients, the release of most nutrients and fixation of N ( Dalbo, 1992 and Kannaiyan, 2002).

Previous studies emphasized the beneficial effects of using mineral N fertilizer, besides both organic and biofertilizers instead of application of mineral N fertilizers alone on growth, vine nutritional status, yield and berries quality in different grapevine cvs (Abd El- Hady, 2003; Ahmed *et al.*, 2003; Shawky *et al.*, 2004; Mahran, 2006; Uwakiem, 2006; El- Sheikh *et al.*, 2006; Ahmed–Ebtsam, 2007; Ahmed *et al.*, 2008; Abd El-Hameed *et al.*, 2010; Abd El- Aziz, 2011; Refaai, 2011; Uwakiem, 2011; Rabie and Negm 2012; Allam- Aida *et al.*, 2012; Ahmed *et al.*, 2012a; Ahmed *et al.*, 2012b Abdelaal *et al.*, 2013 and Shaaban, 2014).

The target of this study was examining the possibility of reducing mineral N fertilizers in Flame seedless vineyards partially by using plant compost

enriched with *Spirulina plantensis* algae for promoting yield and berries quality of Flame grapevines.

### 2. Material and Methods

This study was carried out during 2013 and 2014 seasons on twenty- one uniform in vigour of 9 years- old Flame seedless grapevines. The selected vines are grown in a private vineyard located at Kom El- Arab, Matay district, Minia Governorate where the texture of the soil is clay (Table 1) . Soil analysis was done according to the procedures that outlined by Piper (1950) and Black *et al.* (1965).

The selected vines are planted at 2 x 3 meters apart. The chosen vines were trained by spur (short pruning) pruning system leaving 72 eyes/ vine (15 fruiting spurs x 4 eyes plus six replacement spurs / two eyes) using Gable supporting method. Winter pruning was carried out at the first week of Jan. during both seasons. Surface irrigation system was followed using Nile water.

The selected vines received the common horticultural practices that already applied in the vineyard except those dealing with the application of N in all sources.

**Table (1): Analysis of the tested soil**

Constituent	Values
Sand %	4.0
Silt %	13.0
Clay %	83.0
Texture	Clay
O.M. %	2.41
pH ( 1: 2.5 extract)	7.69
EC ( 1 :2.5 extract) (mmhos/cm/25°C)	0.91
CaCO <sub>3</sub> %	1.55
Total N %	0.09
Available P (Olsen method , ppm)	5.9
Available K ( ammonium acetate , ppm)	4.90

This study consisted from the following seven treatments:

- 1- Application of the suitable N (80 g N / vine / year) as 100% inorganic N (240 g ammonium nitrate / vine/ year) alone.
- 2- Application of the suitable N via 75% inorganic N (180 g ammonium nitrate / vine/ year) alone.
- 3- Application of suitable N via 75% inorganic N + 25% compost enriched with *Spirulina plantensis* algae (1.0 kg plant compost enriched with 40 ml algae/ vine/ year).
- 4- Application of the suitable N as 50 % inorganic N (120 g ammonium nitrate / vine / year) alone.
- 5- Application of the suitable N as 50 % inorganic N + 50 % plant compost enriched with algae (2.0 kg plant compost + 80 ml algae).
- 6- Application of the suitable N as 25% inorganic N (60 g ammonium nitrate / vine / year) alone.
- 7- Application of the suitable N as 25 % inorganic N + 75 % plant compost enriched with algae (3 kg plant compost enriched with 160 ml algae / vine / year).

**Table (2) : Analysis of Plant Compost**

Constituents	Values
pH( 1: 2.5 extract)	8.5
O.M.%	31.0
Total N %	2.0
Total P %	0.52
Total K %	1.12
Total Fe (ppm)	320.0
Total Mn (ppm)	45.0
Total Cu (ppm)	42.0
Total Zn (ppm)	34.0

Each treatment was replicated three times, on vine per each. Ammonium nitrate was divided into four unequal batches and added as 30% at growth start (last week of Feb.), 30% just after berry

setting (middle of April), 20% 21 days after berry setting and 20%, 21 days after harvesting.

Plant Compost was applied once at the middle of January.

Randomized complete block design (RCBD) was adopted for carrying out statistical analysis of the present data.

During both seasons, the following parameters were recorded:

- 1- Vegetative growth characters namely main shoot length (cm); number of leaves /shoot and leaf area (cm<sup>2</sup>) (**Ahmed and Morsy, 1999**).
- 2- Plant pigments namely chlorophylls a & b, total chlorophylls and total carotenoids (mg/ 100 g F.W.) (**Fadl and Seri El-Deen, 1978**).
- 3- Percentages of N, P, K and Mg in the leaves(**Summer, 1985 and Wilde et al., 1985**).
- 4- Percentage of berry setting, yield expressed in weight (kg.) and number of clusters / vine, cluster weight (g.) and dimensions (length & width in cm.)
- 5- Quality of berries namely berry weight (g.) and dimensions (longitudinal and equatorial in cm), juice%, T.S.S. %, reducing sugars %, total acidity % (expressed as tartaric acid/ 100ml juice) (**A.O.A.C., 2000**) and T.S.S./ acid.

Statistical analysis was done using new L.S.D. at 5% (**Mead et al., 1993**).

### 3. Results

#### 1- Some vegetative growth characters.

It is evident from the obtained data Table (3) that varying N management had significant effect on the main shoot length, number of leaves/ shoot and leaf area of Flame seedless grapevines. There was a gradual and significant stimulation on these growth characters with increasing the percentages of inorganic N from 25 to 100% under unorganic and biofertilization. Supplying the vines with N as 25 to 75% inorganic besides plant compost at 25 to 75% + *Spirulina plantensis* algae at 40 to 160 g / vine / year significantly was responsible for enhancing all growth characters rather than carrying out inorganic fertilization alone There was a gradual promotion on these growth traits with reducing inorganic N from 75 to 50% and at the same time increasing both plant compost percentages from 25 to 50% and algae levels from 40 to 80 ml/ vine/ year. Reducing percentages of inorganic N from 50 to 25% under unorganic and biofertilization significantly inhibited these growth characters. The maximum main shoot length (130.3 & 131.0 cm) , number of leaves/ shoot (29.3 & 30.6) leaves and leaf area ( 132.3 & 133.4 cm<sup>2</sup>) during both seasons, respectively were recorded on the vines that fertilized with N as 50% inorganic + 50 % plant compost enriched with 80 ml *Spirulina*

*plantensis* algae/ vine/ year. The lowest values were registered due to supplying the vines with the suitable N via 25% inorganic N alone. These results were true during both seasons.

## 2-Plant pigments.

One can state from the obtained data Tables (3 & 4) that plant pigments namely chlorophylls a & b, total chlorophylls and total carotenoids were significantly affected with varying inorganic, organic and biofertilization of N treatments. All plant pigments were significantly augmented with using the suitable N via all sources whatever proportions used relative to using N via inorganic N source alone. The promotion on these plants pigments was significantly associated with reducing inorganic N percentages from 75 to 25% and at the same time increasing percentage of plant compost from 25 to 75% and algae levels from 0 to 160 ml/ vine/ year. The maximum values of chlorophylls a & b, total chlorophylls and total carotenoids were observed on the vines that fertilized with N as 25% inorganic + 75 % plant compost enriched with 160 ml algae / vine/ year. Under such treatment, total chlorophyll values were 23.7 & 25.6 mg/ 100 g F.W. during both seasons, respectively. The minimum values of these plant pigments were observed on the vines that fertilized with N via 25% inorganic N alone. These results were true during both seasons.

## 3- Percentages of N, P, K and Mg in the leaves.

Data in the Tables (4 & 5) clearly show that under unorganic and biofertilization, increasing percentages of inorganic N from 25 to 100% caused a progressive stimulation on the percentages of N as well as a reduction on the percentages of P, K and Mg in the leaves. All nutrients in the leaves were significantly increased when the suitable N was added in all sources rather than using N via inorganic N alone (without organic and biofertilization). There was a gradual and significant promotion on these nutrients with increasing the percentages of plant compost from 25 to 75%, and levels of *Spirulina plantensis* algae from 40 to 160 ml/ vine / year as well as reducing inorganic N percentages. The lowest values of N were presented on the vines that treated with N as 25% inorganic N without organic and biofertilization. The vines treated with N completely via inorganic N from had the lowest values of P, K and Mg in the leaves. Similar results were announced during 2013 & 2014 seasons.

## 4- Percentage of berry setting , yield and cluster characters.

It is obvious from the obtained data Tables (5 & 6) that inorganic fertilization alone significantly reduced percentage of berry setting, yield expressed N number of clusters per vine and yield in weight (kg.) as well as weight, length and width of cluster comparing to using N via all sources. There was a gradual and significant promotion on berry setting %, yield and cluster characters with reducing inorganic N percentages from 75 to 50% and at the same time increasing plant compost percentages from 25 to 50% and Algae levels from 40 to 80 ml/ vine/ year. However, a significant reduction on these parameters was observed due to reducing percentages of inorganic N from 50 to 25% especially at the absent of organic and biofertilization. The maximum yield (9.6 & 13.3 kg/ vine) was recorded on the vines that fertilized with N as 50% inorganic + 50% plant compost enriched with 80 ml algae/ vine / year. Vines fertilized with N as 100% inorganic N (control vines) produce 7.8 and 9.9 kg during both seasons, respectively. The percentage of increase on the yield due to application of the previous promised treatment (50 inorganic + 50% plant compost + 80 ml algae/ vine/ year) over the check treatment (100% inorganic N) reached 23.1 and 34.3% during 2013 & 2014 seasons, respectively. N management treatments had no significant impact on the number of clusters per vine in the first season of study.

## 5- Physical and chemical characteristics of the berries.

It is noticed from the obtained data in Tables (6 & 7) that quality of the berries was significantly differed among the seven N management treatments. As a general, using N via all sources was significantly preferable than using inorganic N alone in improving fruit quality in terms of increasing berry weight and dimensions (equatorial & longitudinal), juice %, T.S.S.%, reducing sugars % and T.S.S. / acid and decreasing total acidity % relative to using N via inorganic N alone. The promotion on quality of the berries was significantly correlated with reducing the percentages of inorganic N from 75 to 25% and increasing percentages of plant compost from 25 to 75% and algae levels from 40 to 160 ml/ vine/ year. The best results were observed on the vines that fertilized with N as 25 % inorganic + 75% plant compost enriched with algae at 160 ml/ vine/year. Unfavourable effects on fruit quality was attributed to using inorganic N alone at 25% . These results were true during both seasons.

**Table (3): Effect of replacing inorganic N partially by using compost enriched with *Spirulina plantensis* algae on some growth characters and plant pigments of Flame seedless grapevines during 2013 and 2014 seasons.**

Inorganic as well as compost enriched with <i>Spirulina plantensis</i> algae treatments	Main shoot length (cm.)		No. of leaves / shoot		Leaf area (cm <sup>2</sup> )		Chlorophyll a (mg/ 100 g F.W.)		Chlorophyll b (mg/ 100 g F.W.)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
100% inorganic N	123.0	123.7	24.7	26.0	125.0	126.1	13.6	15.0	5.0	5.5
75% inorganic N alone	122.7	123.4	24.0	25.3	124.8	125.9	13.3	14.7	4.9	5.4
75% inorganic 25 % + compost + S.P.	126.7	127.5	27.8	29.1	128.7	129.8	14.1	15.5	5.9	6.4
50% inorganic alone	120.6	121.3	22.0	23.3	122.7	124.0	12.2	13.6	3.9	4.4
50% inorganic N 50% + compost + S.P.	130.3	131.0	29.3	30.6	132.3	133.4	15.1	16.5	6.9	7.4
25 % inorganic alone	118.3	119.0	20.0	21.3	120.4	121.5	11.1	12.5	3.1	3.8
25 % inorganic N 75 % + compost + S.P.	124.1	124.8	25.6	26.9	126.2	127.3	16.2	17.6	7.5	8.0
New L.S.D. at 5%	1.1	1.2	1.7	1.9	1.0	0.9	0.9	1.0	0.6	0.7

S.P. = *Spirulina plantensis* algae**Table (4): Effect of replacing inorganic N partially by using compost enriched with *Spirulina plantensis* algae on total chlorophylls , total carotenoids as well as percentages of N, P and K in the leaves of Flame seedless grapevines during 2013 and 2014 seasons.**

Inorganic as well as compost enriched with <i>Spirulina plantensis</i> algae treatments	Total chlorophylls (mg/ 100 g F.W.)		Total carotenoids (mg/ 100 g F.W.)		Leaf N %		Leaf P %		Leaf K %	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
100% inorganic N	18.6	20.5	3.3	3.0	1.85	1.90	0.22	0.25	1.61	1.54
75% inorganic N alone	18.2	20.1	3.0	2.9	1.84	1.89	0.23	0.26	1.62	1.55
75% inorganic 25 % + compost + S.P.	20.0	21.9	4.0	3.7	1.92	1.97	0.32	0.35	1.90	1.83
50% inorganic alone	16.1	18.0	2.5	2.5	1.71	1.76	0.26	0.29	1.72	1.65
50% inorganic N 50% + compost + S.P.	22.0	23.9	4.6	4.4	1.98	2.03	0.35	0.38	1.96	1.89
25 % inorganic alone	14.2	16.3	2.1	2.2	1.61	1.66	0.29	0.32	1.83	1.79
25 % inorganic N 75 % + compost + S.P.	23.7	25.6	5.3	5.1	2.05	2.11	0.38	0.41	2.00	1.93
New L.S.D. at 5%	0.6	0.7	0.4	0.3	0.06	0.07	0.03	0.02	0.05	0.05

P = *Spirulina plantensis* algae**Table (5): Effect of replacing inorganic N partially by using compost enriched with *Spirulina plantensis* algae on the percentage of magnesium in the leaves , percentage of berry setting , number of clusters/ vine, yield (kg.) and cluster weight of Flame seedless grapevines during 2013 and 2014 seasons.**

Inorganic as well as compost enriched with <i>Spirulina plantensis</i> algae treatments	Leaf Mg %		Berry setting %		No. of clusters / vine		Yield/ vine (kg.)		Cluster weight (g.)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
100% inorganic N	0.64	0.63	17.3	19.0	20.0	25.0	7.8	9.9	392.0	395.0
75% inorganic N alone	0.65	0.62	17.2	18.9	20.0	24.3	7.8	9.6	391.0	394.0
75% inorganic 25 % + compost + S.P.	0.88	0.85	19.0	20.8	21.0	27.0	9.2	11.9	436.0	440.0
50% inorganic alone	0.74	0.71	16.6	18.3	20.0	22.3	7.3	10.5	366.0	470.0
50% inorganic N 50% + compost + S.P.	0.94	0.90	19.9	21.7	21.0	29.0	9.6	13.3	456.0	460.0
25 % inorganic alone	0.81	0.77	16.0	17.7	20.0	20.0	6.8	6.9	341.9	345.0
25 % inorganic N 75 % + compost + S.P.	0.99	0.98	18.2	20.0	21.0	26.0	8.7	10.8	415.0	417.0
New L.S.D. at 5%	0.06	0.06	0.5	0.6	NS	2.0	0.4	0.4	16.0	15.7

P = *Spirulina plantensis* algae

**Table (6):** Effect of replacing inorganic N partially by using compost enriched with *Spirulina plantensis* algae on cluster dimensions (length & width) as well as berry weight and dimensions (longitudinal & equatorial) of Flame seedless grapevines during 2013 and 2014 seasons.

Inorganic as well as compost enriched with <i>Spirulina plantensis</i> algae treatments	Cluster length (cm)		Cluster width (cm)		Berry weight (g.)		Berry longitudinal (cm)		Berry equatorial (cm)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
<b>100% inorganic N</b>	17.2	18.0	12.2	12.0	4.21	4.30	2.28	2.30	2.15	2.18
<b>75% inorganic N alone</b>	17.1	17.9	12.0	11.8	4.20	4.30	2.27	2.29	2.13	2.15
<b>75% inorganic 25 % + compost + S.P.</b>	19.0	19.8	14.0	13.8	4.40	4.50	2.42	2.45	2.29	2.31
<b>50% inorganic alone</b>	16.5	17.4	11.2	11.1	4.05	4.14	2.15	2.18	2.02	2.04
<b>50% inorganic N 50% + compost + S.P.</b>	20.1	21.0	14.7	14.5	4.70	4.80	2.55	2.57	2.42	2.44
<b>25 % inorganic alone</b>	16.0	16.8	10.5	10.2	3.91	4.00	1.99	2.01	1.83	1.85
<b>25 % inorganic N 75 % + compost + S.P.</b>	18.0	18.8	13.3	13.1	4.99	5.10	2.64	2.66	2.50	2.52
<b>New L.S.D. at 5%</b>	0.4	0.4	0.3	0.3	0.09	0.10	0.05	0.04	0.04	0.04

P = *Spirulina plantensis* algae**Table (7):** Effect of replacing inorganic N partially by using compost enriched with *Spirulina plantensis* algae on the percentage of juice as well as some chemical characteristics of Flame seedless grapes during 2013 and 2014 seasons.

Inorganic as well as compost enriched with <i>Spirulina plantensis</i> algae treatments	Juice %		T.S.S. %		Reducing sugars %		Total acidity %		T.S.S./ acid	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
<b>100% inorganic N</b>	55.6	57.0	17.0	17.3	15.3	15.6	0.780	0.773	21.8	22.4
<b>75% inorganic N alone</b>	55.0	56.5	17.3	17.5	15.6	15.8	0.776	0.769	22.3	22.8
<b>75% inorganic 25 % + compost + S.P.</b>	59.0	60.5	18.5	18.8	16.8	17.1	0.710	0.703	26.1	26.7
<b>50% inorganic alone</b>	53.3	54.6	17.6	17.9	15.9	16.2	0.755	0.748	23.3	23.9
<b>50% inorganic N 50% + compost + S.P.</b>	61.0	62.6	19.3	19.6	17.6	18.0	0.675	0.668	28.6	29.3
<b>25 % inorganic alone</b>	51.9	63.5	18.0	18.3	16.3	16.6	0.732	0.725	24.6	25.2
<b>25 % inorganic N 75 % + compost + S.P.</b>	62.9	64.6	19.9	20.2	18.2	18.5	0.641	0.633	31.0	31.9
<b>New L.S.D. at 5%</b>	1.0	1.1	0.3	0.3	0.3	0.3	0.020	0.021	0.6	0.5

P = *Spirulina plantensis* algae

#### 4. Discussion

The previous positive action of organic manure namely plant compost and biofertilization with *Spirulina plantensis* on growth, vine nutritional status, yield and berries quality was attributed mainly to the beneficial effects of these fertilizers in reducing soil salinity, soil pH, leaching process and soil erosion and enhancing the production of natural hormones namely IAA, GA<sub>3</sub> and cytokinins, root development, nutrient availability, soil organic matter, microbial activity; soil aggregation and aeration, permeability of soil, water holding capacity, nutrient transport, photosynthesis process, fixation of N, water use efficiency, vitamins B, solubility of most nutrients, soil workability, antibiotics, resistant to drought, formation of humus and converting of insoluble sulphur to soluble one (Dalbo, 1992 and Davis and Ghabbour, 1998). 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); Uwakiem (2011); Rabie and Negm (2012); Allam – Aida *et al.*, (2012), Ahmed *et al.*, (2012a) and (2012b); El- Khafagy (2013); Abdelaal *et al.*, (2013) and Abd El- Kareem (2014) on different grapevine cvs.

#### Conclusion:

The best results with regard to yield and fruit quality of Flame seedless grapevines were recorded when the vines fertilized with N (80g N/ vine / year) via 50% inorganic + 50 % plant compost enriched with *Spirulina plantensis* at 80 ml/ vine/ year.

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