Adjusting the Suitable Amount of Inorganic, Organic and Biofertilizers of N for Maximizing Growth of *Epipremnum pinnatum Aureum* Bunt Plants

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Abstract: This study was carried out during 2010 and 2011 seasons in a greenhouse of the experimental Farm of King Abdulaziz Univ. at Hoda Al- Sham, Jaddah, Saudi Arabia. *Epipremnum pinnatum* plants grown in 30 cm plastic pots were fertilized with N through inorganic, inorganic + organic or inorganic + organic + bioform. Sources of inorganic, organic and biofertilizers of N were ammonium sulphate, compost and Nitrobien biofertilizer, respectively. This study focused on selecting the best N management that was responsible for maximizing growth of these plants. Results showed that fertilizing of *Epipremnum pinnatum* plants with N through inorganic, organic and bioform was very effective in enhancing growth characters namely height, number of leaves/ plant, leaf dimensions, stem dimensions, foliage dry weight/ plant, plant pigments and different sugars in relative to using one or two sources of N alone. Negligible stimulation was observed with increasing compost levels from 8 to 16/ plant and Nitrobien levels from 4 to 8 ml/ plant. Supplying *Epipremnum pinnatum Aureum* Bunt plants with N via 2 g ammonium sulphate, 8 g compost and 4 ml Nitrobien biofertilizer per plant was very responsible for stimulating growth and nutritional status of the plants.

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1. Introduction

Epipremnum pinnatum Aureum Bunt plants belong to the Araceae family and one among the most popular house plants. Like all indoor foliage plants, the quality of these plants and their ability to grow vigorously indoors depend to a great extent on the environmental conditions (light intensity, relative humidity, etc.) under which the cultural practices used for the maintenance of the plants (especially N fertilization). Indoor plants are usually exposed to relatively low light intensities. Under such conditions, the nutritional requirements of the plants are limited and excessive N fertilization or using one source of N may have no marked effect on plant growth and nutritional status. It is therefore, very important to supply indoor foliage plants with a balanced N management containing all sources of N (inorganic, organic and bioforms) for protecting our environment from great pollution, as well as enhancing growth of these plants.

Generally, N has many functions in ornamental plants. It is responsible for enhancing most organic foods and cell division **(Yagodin, 1990).** Organic and biofertilizations have positive action in enhancing soil fertility and secreting natural hormones, antibiotics and vitamins B **(Kannaiyan, 2002).**

Previous studies showed that using N in all sources (inorganic, organic and bioforms) is essential for promoting growth of indoor plants comparing with using N through inorganic N alone **(Said, 1997; El- Deeb, 1999 and Salem *et al*., 2002a and 2002b).** Several scientists have also shown that organic and biofertilization are essential for the growth of different ornamental plants in relative to application of mineral N alone **(Abdou, 2004a and 2004b, Heikal, 2005; Abdou *et al*., 2006; Erika *et al*., 2008; Abdalla, 2009; Abdou *et al*., 2009a, 2009b and 2009c; Abd El- Hadi *et al*., 2009; Ardelan *et al*., 2010 and Abdou *et al*., 2011).**

This study was conducted to examine the effect of using N in all forms on growth of *Epipremnum pinnatum Aureum* Bunt plants. The merit also was selecting the best N management required for maximizing growth of these plants. These findings can be used as guidelines for N fertilization with all sources of other indoor plants of similar growth patterns.

2. Material and Methods

This investigation was carried out under the greenhouse of the experimental Farm of King Abdulaziz Univ. at Hoda Al- Sham that located about 120 km northeast of Jaddah, Saudi Arabia during 2010 and 2011 seasons. One hundred and sixty- five uniform rooted cuttings of *Epipremnum pinnatum Aureum* having 4 -5 leaves and 8 – 10 cm height were selected for achieving this study.

On the first week of May in both seasons, rooted cuttings of *Epipremnum pinnatum Aureum* were individually planted in 30 cm plastic pots. Each pot was filled with 3 kg planting media comprised from 1 part peat moss: 1 part sand. Each pot contains one plant. The plants were subjected to the following eleven treatments from different inorganic, organic and biofertilization:-

1. Control (untreated plants).
2. Application of ammonium sulphate (20.6 % N) at 4 g/ plant.
3. Application of ammonium sulphate at 2 g/ plant + compost at 4 g/ plant.
4. Application of ammonium sulphate at 2 g/ plant + compost at 4 g/ plant + Nitrobien at 4 ml/ plant.
5. Application of ammonium sulphate at 2 g/ plant + compost at 4 g/ plant + Nitrobien at 8 ml/ plant.
6. Application of ammonium sulphate at 2 g/ plant + compost at 8 g/ plant.
7. Application of ammonium sulphate at 2 g/ plant + compost at 8 g/ plant + Nitrobien at 4 ml/ plant.
8. Application of ammonium sulphate at 2 g/ plant + compost at 8 g/ plant + Nitrobien at 8 ml/ plant.
9. Application of ammonium sulphate at 2 g/ plant + compost at 16 g/ plant.
10. Application of ammonium sulphate at 2 g/ plant + compost at 16 g/ plant + Nitrobien at 4 ml/ plant.
11. Application of ammonium sulphate at 2 g/ plant + compost at 16 g/ plant + Nitrobien at 8 ml/ plant.

Plant compost was added to the media (1 part peat moss: 1 part sand) before filling the pots. Fresh and active biofertilizer Nitobien (1 ml contains 10^7 cells of *Azotobacter* bacteria) exported from Egypt was applied once with compost (before filling the pots). Ammonium sulphate (20.6 % N) was divided into two equal portions applied at one and two months after transplanting. The selected plants received potassium and phosphorus fertilizers as 2 g calcium superphosphate (15.5 % P_2O_5) and 0.5 g potassium sulphate (48 % K_2O) per each plant annually. They were applied at two equal doses at 4 and 8 weeks after transplanting. Irrigation was done from May to October by supplying each pot with 750 ml water (about 80 % of field capacity) daily in summer (May, June, July and August) and every second day during Sept. and Oct.

Physical and chemical characters of the planting media and compost are shown in Tables (1 & 2).

Table (1): analysis of planting media

pH	EC ds/ m	Anions & cations (me q/ 1 L)						
		HCO_3 & CO_3^-	Cl^+	SO_4^-	Ca^{++}	Mg^{++}	K^+	Na^+
6.11	1.10	0.6	1.6	4.2	3.3	4.4	1.61	2.9

Table (2): analysis of compost

Moisture %	pH	EC ds/m	OM %	N %	P %	K %	Fe ppm	Mn ppm	Zn ppm	Cu ppm
26	8.2	4.1	65.0	2.15	1.5	1.3	1025	115	180	28

The design of the experiment was completely randomized with eleven treatments and each treatment was replicated three times, five plants per each.

The following data were recorded after 6 months from planting the plants:-

1. Plant height (cm.).
2. Number of leaves plant.
3. Length of leaf (cm.).
4. Cross of leaf (cm.).
5. Stem diameter (mm.).
6. Foliage dry weight/ plant (g.).
7. Plant pigments namely chlorophylls a & b and total chlorophylls (mg/ 1 g. fresh weight) were determined in the fresh leaves as described by **Saric *et al*. (1976).**
8. Percentages of N, P, K and Mg in the leaves were determined on dry weight basis according to the procedures that outlined by **Chapman and Pratt (1965) and Wilde *et al*. (1985).**
9. Percentages of soluble, insoluble and total sugars in the leaves were determined (according to **A.O.A.C., 1995**).

The obtained data were statistically analyzed according to **Mead *et al*. (1993).** New L.S.D test was used for comparisons between means of the different treatments.

3. Results and Discussion

1. Vegetative growth characters:

Data in Tables (3 & 4) show that all inorganic, organic and biofertilizations of N significantly stimulated all growth characters namely plant height, number of leaves/ plant, leaf dimensions (length and cross), stem diameter and foliage dry weight in relative to the control treatment. The promotion was associated with increasing levels of compost from 4 to 16 g./ plant and Nitrobien from 0.0 to 8 ml./ plant. Application of N in all sources (ammonium sulphate, compost and Nitrobien biofertilizer) was significantly favourable in enhancing these growth characters comparing with using N via inorganic form alone or when N was applied via inorganic and organic N sources alone. Increasing levels of compost from 8 to 16 g/ plant as well as levels of Nitrobien biofertilizer from 4 to 8 ml/ plant failed to show significant stimulation on these growth aspects. Significant differences on these growth traits were observed among all fertilization treatments. The maximum values were recorded with supplying the plants with N through 2 g ammonium sulphate, 16 g. compost and 8 ml Nitrobien biofertilizer per plant. Untreated plants had the lowest values. These results were true during both seasons.

The beneficial effect of organic and biofertilization on reducing soil pH and enhancing organic matter, uptake and availability of different nutrients, antibiotics, natural hormones (IAA, GA_3 and cytokinins) and B vitamins surely reflected on enhancing growth characters (Yagodin, 1990 and Kanniyan, 2002).

These results are in agreement with those obtained by Said (1997) on croton; El- Deeb (1999) on some foliage plants; Salem *et al*. (2002a) on hedra helix; Ardelan *et al*., (2010) on *Satureja hortensis* and Abdou *et al*. (2011) on Clove Basil.

2. Chemical composition of the leaves:

2-1 Plant pigments:

It is clear from the data in Tables (4 & 5) that inorganic, organic and biofertilization of N significantly was accompanied with stimulating chlorophylls a & b and total chlorophylls in relative to the check treatment. The promotion on such pigments was associated significantly with increasing number of N sources as well as increasing levels of compost from 4 to 16 g/ plant and Nitrobien biofertilizer from 2 to 8 ml/ plant. Increasing levels of compost from 8 to 16 g/ plant and levels of Nitrobien biofertilizer from 4 to 8 ml/ plant failed significantly to show measurable stimulation on such plant pigments. Application of all sources of N was superior than application of one or two sources of N alone in enhancing plant pigments. Fertilizing of the plants with N via 2 g ammonium sulphate, 16 g compost and 8 ml Nitrobien biofertilizer per plant gave the maximum values. The lowest values were recorded with unfertilization. Similar trend was noticed during both seasons.

The positive action of organic and biofertilization on enhancing the uptake of N and magnesium and other nutrients surely reflected on stimulating plant pigments (Yagodin, 1990 and Kanniyan, 2002).

These results are in agreement with those obtained by **Said (1997)** on croton; **El- Deeb (1999)** on some foliage plants; Salem *et al*., (2002a) on hedra helix; Ardelan *et al*., (2010) on Satureja hortensis and Abdou *et al*. (2011) on Clove Basil.

2-2 Percentages of N, P, K and Mg in the leaves:

It is obvious from the data in Tables (5 & 6) that fertilization of the plants with N via inorganic and organic and biofertilization significantly was accompanied with enhancing N % in the leaves in relative to unfertilization. However, percentages of P, K and Mg were significantly reduced with using N via inorganic form only in relative to using inorganic form with organic and biofertilization. Combined application of all sources of N was superior than using one or two sources alone in enhancing the percentages of N, P, K and Mg. The promotion was associated with increasing levels of compost and Nitrobien biofertilizer. Increasing levels of compost from 8 to 16 g./ plant and Nitrobien biofertilizer from 4 to 8 ml/ plant had meaningless promotion on these nutrients. Application of the suitable N through 2 g ammonium sulphate, 16 g. compost and 8 ml Nitrobien/ plant effectively maximized these nutrients. Inorganic fertilization alone gave the minimum values of P, K and Mg. While unfertilization gave the lowest values of N. These results were true during both the experimental seasons.

The beneficial effect of organic and biofertilization on enhancing soil fertility expressed in lowering soil pH and enhancing organic matter and fixation of atmospheric N surely reflected on enhancing the availability of various nutrients (Yagodin, 1990 and Kanniyan, 2002).

These results are in harmony with those obtained by Abdalla (2009) on coriander and Abdou *et al*., (2011) on clove Basil.

2-3 Soluble, non- soluble and total sugars percentages:

It is evident from the data in Table (6) that fertilization with N regardless the source applied significantly was followed by enhancing soluble, non soluble and total sugars percentages comparing with unfertilization. Supplying the plants with N via all sources was significantly favourable in improving such chemical characteristics rather than application of one or two sources of N. Increasing compost and Nitrobien levels was followed by gradual promotion on such chemical traits. Combined application of inorganic + organic + bioforms as of N was preferable than using inorganic + organic in enhancing soluble, non- soluble and total sugars %. The maximum values were recorded with amending the plants with N via 2 g ammonium sulphate + 16 g compost + 8 ml Nitrobien/ plant. The lowest values were recorded on unfertilized plants. Similar trend was noticed during 2010 and 2011 seasons.

The beneficial effect of organic and biofertilization on enhancing the availability of N, P, K, Mg and B could result in enhancing the biosynthesis of carbohydrates. The great release of CO_2 around the plants with organic and biofertilization surely reflected on enhancing photosynthesis process (Kanniyan, 2002).

These results are in agreement with those obtained by Salem *et al.* (2002b) on *Scindapsus pictus* plants.

As a conclusion, for promoting growth of *Epipremnum pinnatum Aureum* Bunt plants, it is advised to fertilize the plants with N through 2 g ammonium sulphate, 8 g compost and 4 ml Nitrobien/ plant annually.

Table (3): Effect of inorganic, organic and biofertilization of N on some growth characters of *Epipremnum pinnatum* plants during 2010 and 2011 seasons.

Inorganic, organic and bioforms of N treatments	Plant height (cm.)		No. of leaves/ plant		Leaf length (cm.)		Leaf cross (cm.)	
	2010	2011	2010	2011	2010	2011	2010	2011
Control (unfertilization).	72.5	100.0	14.2	16.2	8.0	8.4	5.0	5.2
Ammonium sulphate at 4 g/ plant.	80.7	109.0	16.3	18.3	8.6	9.0	5.3	5.5
Ammonium sulphate at 2 g/ plant (AS) + compost at 4 g/ plant.	91.0	121.0	18.5	20.6	9.2	9.6	5.5	5.7
AS + compost at 4 g/ plant + Nitrobien at 4 g/ plant.	100.0	130.0	23.0	25.0	10.9	11.5	6.2	6.5
AS + compost at 4 g/ plant + Nitrobien at 8 g/ plant.	101.0	131.0	23.5	25.4	11.0	11.6	6.3	6.5
AS + compost at 8 g/ plant.	95.0	125.9	20.7	23.0	10.0	10.5	5.8	6.0
AS + compost at 8 g/ plant + Nitrobien at 4 ml/ plant.	119.0	150.0	27.0	29.2	11.6	12.0	6.5	6.7
AS + compost at 8 g/ plant + Nitrobien at 8 ml/ plant.	120.0	151.0	27.6	29.5	11.7	12.1	6.6	6.8
AS + compost at 16 g/ plant.	95.7	126.0	20.9	23.5	10.1	10.5	5.9	6.1
AS + compost at 16 g/ plant + Nitrobien at 4 ml/ plant.	120.0	151.0	27.5	30.0	11.7	12.1	6.6	6.8
AS + compost at 16 g/ plant + Nitrobien at 8 ml/ plant.	120.0	151.2	27.8	30.5	11.8	12.3	6.7	6.9
New L.S.D at 5 %	**2.3**	**2.2**	**1.4**	**1.3**	**0.4**	**0.4**	**0.2**	**0.2**

Table (4): Effect of inorganic, organic and biofertilization of N on stem diameter, foliage dry weight and chlorophylls a and b of *Epipremnum pinnatum* plants during 2010 and 2011 seasons.

Inorganic, organic and bioforms of N treatments	Stem diameter (mm.)		Foliage dry weight (g.)		Chlorophyll a (mg/ 1 /g FW)		Chlorophyll b (mg/ 1 /g FW)	
	2010	2011	2010	2011	2010	2011	2010	2011
Control (unfertilization).	2.7	2.8	7.7	8.0	2.01	2.12	1.22	1.27
Ammonium sulphate at 4 g/ plant.	3.0	3.1	8.4	8.8	2.21	2.33	1.35	1.41
Ammonium sulphate at 2 g/ plant (AS) + compost at 4 g/ plant.	3.3	3.4	9.1	9.5	2.51	2.62	1.48	1.54
AS + compost at 4 g/ plant + Nitrobien at 4 g/ plant.	4.0	4.1	11.0	11.4	3.41	3.52	1.77	1.83
AS + compost at 4 g/ plant + Nitrobien at 8 g/ plant.	4.1	4.2	11.2	11.5	3.44	3.55	1.80	1.86
AS + compost at 8 g/ plant.	3.6	3.7	10.0	10.3	2.75	2.86	1.61	1.67
AS + compost at 8 g/ plant + Nitrobien at 4 ml/ plant.	4.4	4.5	12.9	13.1	3.56	3.67	1.95	2.01
AS + compost at 8 g/ plant + Nitrobien at 8 ml/ plant.	4.5	4.6	13.0	13.3	3.57	3.69	1.96	2.02
AS + compost at 16 g/ plant.	3.7	3.8	10.1	10.4	2.71	2.88	1.63	1.69
AS + compost at 16 g/ plant + Nitrobien at 4 ml/ plant.	4.5	4.6	13.0	13.3	3.58	3.68	1.97	2.02
AS + compost at 16 g/ plant + Nitrobien at 8 ml/ plant.	4.6	4.7	13.2	13.5	3.60	3.70	1.99	2.03
New L.S.D at 5 %	**0.2**	**0.2**	**0.5**	**0.5**	**0.12**	**0.13**	**0.11**	**0.12**

Table (5): Effect of inorganic, organic and biofertilization of N on total chlorophylls and percentages of N, P and K in the leaves of *Epipremnum pinnatum* plants during 2010 and 2011 seasons.

Inorganic, organic and bioforms of N treatments	Total Chlorophylls (mg/ 1 /g FW)		N %		P %		K %	
	2010	2011	2010	2011	2010	2011	2010	2011
Control (unfertilization).	3.34	3.39	1.62	1.67	0.40	0.39	1.16	1.18
Ammonium sulphate at 4 g/ plant.	3.56	3.74	1.71	1.76	0.36	0.35	1.13	1.15
Ammonium sulphate at 2 g/ plant (AS) + compost at 4 g/ plant.	3.99	4.16	1.80	1.86	0.41	0.43	1.20	1.22
AS + compost at 4 g/ plant + Nitrobien at 4 g/ plant.	5.18	5.35	1.97	2.03	0.50	0.49	1.29	1.31
AS + compost at 4 g/ plant + Nitrobien at 8 g/ plant.	5.24	5.41	1.98	2.04	0.51	0.50	1.30	1.32
AS + compost at 8 g/ plant.	4.36	4.53	1.88	1.94	0.44	0.45	1.24	1.26
AS + compost at 8 g/ plant + Nitrobien at 4 ml/ plant.	5.51	5.68	2.10	2.16	0.55	0.54	1.32	1.33
AS + compost at 8 g/ plant + Nitrobien at 8 ml/ plant.	5.53	5.71	2.11	2.17	0.56	0.56	1.33	1.34
AS + compost at 16 g/ plant.	4.39	4.57	1.90	1.96	0.45	0.46	1.25	1.27
AS + compost at 16 g/ plant + Nitrobien at 4 ml/ plant.	5.55	5.70	2.11	2.17	0.56	0.55	1.33	1.34
AS + compost at 16 g/ plant + Nitrobien at 8 ml/ plant.	5.59	5.73	2.12	2.18	0.57	0.57	1.34	1.35
New L.S.D at 5 %	**0.13**	**0.13**	**0.05**	**0.05**	**0.02**	**0.02**	**0.04**	**0.04**

Table (6): Effect of inorganic, organic and biofertilization of N on percentage of Mg, soluble sugars, non- soluble sugars and total sugars % of *Epipremnum pinnatum* plants during 2010 and 2011 seasons.

Inorganic, organic and bioforms of N treatments	Mg %		Soluble sugars %		Non- soluble sugars %		Total sugars %	
	2010	2011	2010	2011	2010	2011	2010	2011
Control (unfertilization).	0.62	0.36	4.6	4.7	5.5	5.6	10.1	10.3
Ammonium sulphate at 4 g/ plant.	0.57	0.58	4.8	4.9	5.7	5.8	10.5	10.7
Ammonium sulphate at 2 g/ plant (AS) + compost at 4 g/ plant.	0.65	0.66	5.0	5.1	5.9	6.0	10.9	11.1
AS + compost at 4 g/ plant + Nitrobien at 4 g/ plant.	0.72	0.73	5.9	6.0	6.8	6.9	12.7	12.9
AS + compost at 4 g/ plant + Nitrobien at 8 g/ plant.	0.73	0.74	6.0	6.1	6.9	7.0	12.9	13.1
AS + compost at 8 g/ plant.	0.68	0.69	5.2	5.3	6.1	6.2	11.3	11.5
AS + compost at 8 g/ plant + Nitrobien at 4 ml/ plant.	0.77	0.78	6.3	6.4	7.2	7.3	13.5	13.7
AS + compost at 8 g/ plant + Nitrobien at 8 ml/ plant.	0.78	0.79	6.4	6.5	7.4	7.5	13.8	14.0
AS + compost at 16 g/ plant.	0.69	0.70	5.6	5.7	6.5	6.6	12.1	12.3
AS + compost at 16 g/ plant + Nitrobien at 4 ml/ plant.	0.79	0.80	6.4	6.5	7.3	7.4	13.7	13.9
AS + compost at 16 g/ plant + Nitrobien at 8 ml/ plant.	0.80	0.81	6.5	6.6	7.4	7.5	13.9	14.1
New L.S.D at 5 %	**0.03**	**0.03**	**0.2**	**0.2**	**0.2**	**0.2**	**0.3**	**0.2**

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