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IMPROVING EFFICIENCY OF NPK FERTILIZER FOR SPATHIPHYLLUM PLANT BY USING ACTIVE DRY YEAST AT VARIOUS LEVELS

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ABSTRACT

A set of pot experiments was conducted under saranhouse (65% shade) at the nursery of Hort. Res. Inst., ARC, Giza, Egypt during 2009 and 2010 seasons to study the effect of NPK mixed fertilizer (2:2:1) at 0 and 2g/pot as a soil drench and active dry yeast at 0, 2, 4 and 6 g/l as a foliar spray, alone or in combinations on growth, flowering and chemical composition of one-year-old transplants of *Spathiphyllum wallisii* grown in 20-cm-diameter plastic pots filled with about 2.5 kg of sand, clay and peatmoss mixture (1:1:1, v/v/v), when added five times with one month interval throughout the growing season.

The obtained results indicated that all fertilization treatments applied in this work caused a marked increment in plant height (cm), No. leaves/plant, leaf area (cm^2), root length (cm), No. roots/plant and leaves and roots fresh and dry weights (g) with various significant differences as compared to control treatment in both seasons. Flowering stalk length (cm), as well as spathe length (cm) and fresh weight (g) also exhibited a similar trend. An increment was also observed in the leaves content of chlorophylls a and b, carotenoids and reduced sugars due to the various employed treatments. The combination between NPK mixture at 2g/pot and any level of active dry yeast resulted additional increasing in the means of all previous measurements, while the superiority in most traits was for the combination of 2g/pot NPK mixture + 4g/l active dry yeast, which gave the highest records in the two seasons.

Hence, it could be recommended to fertilize one-year-old transplants of *Spathiphyllum wallisii* grown in 20-cm-diameter plastic pots filled with 2.5 kg of sand, clay and peatmoss mixture (1:1:1, v/v/v) with 2 g/pot NPK mixture as a soil drench plus 4 g/l active dry yeast as a foliar spray, five times at one month interval to obtain the best growth, flowering and highest quality of plants.

INTRODUCTION

Spathiphyllum wallisii Schott. (Fam: Araceae), is a stemless or very short-stemmed herb, used as a warmhouse foliage pot-plant. Genus name referring to the leaf-like spathes. Leaves large, oblong or lanceolate, acuminate, midrib strong; spathe leaf-like, membranaceous, oblong or lanceolate, white or cream. Native to Tropical America. Gardeners recommend as medium for its cultivating a mixture of leaf-mold, peat and fibrous loam, together with some sand and charcoal (Bailey, 1976).

Fertilization is still the most important agricultural process necessary for improving growth and quality of plants, especially flowering and foliage pot plants, among of them Spathiphyllum one, as these plants usually grow within a limited space not exceed 3/4 of pot size, and undergo bad aeration, besides the low illumination which may reduce or slow photosynthesis process in the leaves, and consequently depress the food formation. So, fertilization under these stresses is obligatory. This was emphasized by Poole and Chase (1987) who found that a 20 N- 9 P – 17 K fertilizer at the rate of 10.5g/9 litres was generally the best treatment for growth and flowering of Spathiphyllum cv. Mauna Loa plants. Likewise, Poole and Conover (1992) mentioned that height and plant grade of Spathiphyllum cv. Petite were increased when the rate of 24N-3.5P-13K fertilizer was increased from 0.21 to 0.42g/litre of water, but height was increased and plant grade did not improve when fertilizer rates rose beyond 0.42 g/litre. On the same cultivar (cv. Petite), Maciel *et al.,* (2003) postulated that leaf number, fresh and dry weights of shoots; as well as number and fresh and dry weights of roots were significantly improved when 20:20:20 NPK + microelements fertilizer was applied as a foliar spray. On "Jetty" Spathiphyllum, Broschat (2006) revealed that using osmocote + 15-9-12 NPK fertilizer gave the greatest shoot and root dry weights, and the highest content of chlorophylls.

Using active dry yeast to improve plant growth was noticed by some workers. In this regard, Desouky (2004) stated that a combination of NPK at 100:60:20 g/plant + active dry yeast at 2 g/plant greatly increased plant height, leaf number/plant, petiole length, leaf area, flower spike number/plant, spike stalk length, stalk diameter, offsets number/plant, as well as foliage and spike fresh and dry weights of *Strelitzia reginae* plants. Total carbohydrates and elements content (N, P, K, Ca, Mg, Fe, Mn, Zn and Cu) in vegetative parts were also increased. Similarly, Abdel-Wahed *et al.,* (2006) claimed that using yeast twice at 4g/l plus 6g NPK/plant significantly increased height, fresh and dry weights of shoots and N% in roots of *Euonymus japonicus* plant, while yeast alone led to an increment in No. branches, stem diameter, root length, fresh and dry weights of roots, carotenoids content in the leaves and K% in roots. On the same line, were those results of Abdel-Fattah *et al.,* (2009) on *Brassaia actinohylla.*

This work, however, was done to investigate the individual or the combined effects of NPK fertilizer and yeast on growth, flowering and chemical composition of Spathiphyllum pot plant.

MATERIALS AND METHODS

A series of pot experiments was consummated under saranhouse (65% shade) at nursery of Hort. Res. Inst., ARC, Gizza, Egypt throughout the two successive seasons of 2009 and 2010 to find out the effect of NPK fertilizer and yeast, alone or in combinations on growth, flowering and quality of Spathiphyllum plant.

Therefore, one-year-old transplants of *Spathiphyllum wallisii* Schott. (a local variety) bearing of about 18±1 cm height and carrying about 4-5 leaves were planted on March, 15th for both seasons in 20-cm-diameter plastic pots (one transplant/pot) filled with about 2.5 kg of an equal mixture of sand, clay and peatmoss (1:1:1, by volume). The physical and chemical properties of the used sand and clay in the two seasons are shown in Table (a), while those of peatmoss are shown in Table (b).

Table (a): Some physical and chemical properties of the used sand and clay during 2009 and 2010 seasons.

Soil type	seasons	Particle size distribution (%)				S.P	E.C. (ds/m)	pH	Cations (meq/l)				Anions (meq/l)		
		Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
Sand	2009	89.03	2.05	0.40	8.52	23.01	3.56	7.90	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2010	84.76	6.29	1.50	7.45	21.87	3.71	7.80	19.42	8.33	7.20	0.75	1.60	7.80	26.30
Clay	2009	10.18	46.17	19.53	24.12	35.00	3.48	8.27	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	2010	10.30	46.54	18.88	24.28	33.07	3.36	7.96	18.00	8.95	20.50	0.85	3.65	10.20	34.45

Table (b): Some physical and chemical properties of the used peatmoss in the two seasons.

Organic matter……	90-95%	**P**……..	0.23%
Ash……	5-10%	**K**……..…	1.77 %
Density (Vol. Dry) ……..	80-90	**Fe**……..…	421 ppm
pH value…….....	3.4	**Mn**……	27 ppm
Water relation capacity...	60-75%	**Zn**……..…	41 ppm
Salinity……....	0.3 g/l.	**Cu**……..……	8.8 ppm
N……....	1.09 %	**Mg**	3.3 ppm

The layout of the experiments in both seasons was a complete randomized design (Mead *et al.,* 1993) with three replicates, as each replicate contained five plants. After two weeks from planting (on April, 1st), the transplants received the following treatments:

1- No fertilization, referred to as control.
2- Chemical fertilization with a mixture of NPK (2:2:1) at the rate of 2g/pot, added as a soil drench, five times with one month interval. Ammonium sulphate (20.5%N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48.5% K_2O) fertilizers were used to obtain the required ratio.
3- Biofertilization with an aqueous solution of active dry yeast at the rates of 2, 4 and 6 g/l combined with 30 g sucrose/l were applied as a foliar spray, five times with one month interval till solution run-off. The chemical composition of the active dry yeast used in the two seasons are averaged in Table (c).

4- Each level of yeast was combined with a mixture of NPK (2:2:1) at the rate of 2 g/pot to form 3 combinations as follows:

a- Active dry yeast at 2g/l + 2g NPK mixture/pot.

b- Active dry yeast at 4g/l + 2g NPK mixture/pot.

c- Active dry yeast at 6g/l + 2g NPK mixture/pot.

Table (c): Chemical composition of the active dry yeast used in the two seasons.

Proteins	47.0%	**Niacin**	300-500 µ/g
Carbohydrates	33.0%	**Pyrodoxin**	28.0 µ/g
Minerals	8.0%	**Pantathenate**	70.0 µ/g
Nucleic acids	8.0%	**Biotin**	1.3 µ/g
Lipids	4.0%	**Cholin**	4000 µ/g
Thiamine	60-100µ/g	**Folic acid**	5.13 µ/g
Riboflavin	35-50 µ/g	**Vit. B12**	0.001 µ/g
Approximate composition of minerals (mg/g):			
Na	0.12	**Cu**	8.0
Ca	0.75	**Se**	0.1
Fe	0.02	**Mn**	0.02
Mg	1.65	**Cr**	2.2
K	21.0	**Ni**	3.0
P	13.5	**Va**	0.04
S	3.9	**Mo**	0.4
Zn	0.17	**Sn**	3.0
Si	0.03	**Li**	0.17

The regular agricultural practices recommended for this plantation were carried out whenever needed.

At the end of each season (30th of Sept.), the following data were recorded: plant height (cm), number of leaves/plant, leaf area (cm^2), leaves fresh and dry weights (g), the longest root length (cm), number of roots/plant, as well as roots fresh and dry weights (g). In addition, flowering stalk length (cm) and spathe length (cm) and its fresh weight (g) were measured. In fresh leaf samples taken from the middle part of the plant, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g F.W.) were determined according to Moran (1982), while in dry ones, reduced sugars (mg/g D.W.) were evaluated using the colorimetric method of Smith *et al.,* (1956).

Data were then tabulated and subjected to analysis of variance according to SAS program (1994) using Duncan's Multiple Range Test (1955) for detecting the significancy level among the means of various treatments.

RESULTS AND DISCUSSION

Effect of fertilization treatments on:

1- Vegetative growth parameters:

It is obvious from data in Table (1) that all fertilization treatments used in this study caused a marked increment in plant height (cm), No. leaves/plant, leaf area (cm^2) and leaves fresh and dry weights (g) with various significant differences as compared to control treatment in the two seasons.

Table (1) Effect of fertilization treatments on some vegetative growth parameters of *Spathiphyllum wallisii* Schott plants during 2009 and 2010 seasons.

Treatments	Plant height (cm)		No. leaves per plant		Leaf area (cm^2)		Leaves F.W. (g)		Leaves D.W. (g)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Control	38.50 c	41.20 b	9.67 c	10.27 c	51.83 e	46.93 e	27.77 c	29.64 d	6.78 b	7.24 b
NPK at 2g/pot (A)	39.50 bc	43.30 ab	10.33 bc	11.03 b	69.25 d	63.03 d	31.45 cb	33.60 c	6.98 b	7.36 b
Yeast at 2g/l (B)	39.33 bc	42.67 b	11.46 b	12.00 ab	81.33 c	73.80 c	29.30 c	31.35 d	6.83 b	7.30 b
Yeast at 4g/l (C)	42.80 ab	45.00 a	11.33 b	12.10 ab	91.17 bc	82.63 bc	35.16 b	37.67 b	8.00 b	8.58 b
Yeast at 6g/l (D)	41.17 b	43.19 ab	11.98 ba	13.30 a	92.00 b	81.90 bc	37.83 b	40.66 b	8.47 ab	8.71 b
A + B	41.68 b	45.00 a	10.53 bc	11.16 b	96.73 b	87.69 b	43.10 ab	47.10 a	9.33 ab	10.38 a
A + C	43.76 ab	47.08 a	13.00 ab	14.78 a	110.20 a	103.10 a	42.21 ab	47.08 a	10.14 ab	11.20 a
A + D	45.67 a	46.33 a	14.33 a	14.10 a	101.50 ab	92.46 ab	45.27 a	45.00 ab	12.10 a	11.03 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

However, the combination between active dry yeast at any concentration and NPK mixture at 2g/pot resulted additional increasing in the means of all previous parameters, with the superiority of combinations between NPK fertilizer at 2g/pot and yeast at either 4 or 6 g/l, as these two combinations gave the highest means which were closely near together with non-significant differences in between in some cases of the two seasons. This may be attributed to the synergistic effect of both NPK as vital components more effective on promoting growth and development (Thiffault and Jabidon, 2006) and yeast as a source of proteins, amino acids, ash, glycogen, fats, cellulose and vitamin B (Ahmed, 1998).

These results are in harmony with those detected by Poole and Conover (1992) and Maciel *et al.,* (2003) on Spathiphyllum cv. Petite, Desouky (2004) on bird of paradise and Abdel-Wahed *et al.,* (2006) on *Euonymus japonicus.*

2- Root growth parameters:

As shown in Table (2), data point out that root length (cm), No. roots/plant and roots fresh and dry weights (g) were significantly increased in response to either drenching soil with NPK mixture at 2 g/pot or spraying the foliage with yeast at the various levels. The maximum values, were however obtained by the combined treatments between the medium and high levels of active dry yeast (4 and 6 g/l, respectively) and 2g/pot NPK mixture, with the prevalence of a combination which contained yeast at 4 g/l over that one contained 6g/l yeast, as the former gave slightly higher means than the later with non-significant differences in between in both seasons.

Table (2) Effect of fertilization treatments on roots growth of *Spathiphyllum wallisii* Schott plants during 2009 and 2010 seasons.

Treatments	Root length (cm)		No. roots/plant		Roots F.W. (g)		Roots D.W. (g)	
	2009	2010	2009	2010	2009	2010	2009	2010
Control	23.33 c	24.58 c	16.67 d	20.00 e	14.98 d	17.96 d	4.15 b	4.98 c
NPK at 2g/pot (A)	23.83 c	28.16 b	20.33 c	25.33 d	15.86 cd	19.79 cd	4.80 b	5.99 bc
Yeast at 2g/l (B)	24.00 bc	25.33 c	20.00 c	24.00 d	17.45 c	21.00 c	5.31 ba	6.38 b
Yeast at 4g/l (C)	27.86 ab	26.19 bc	24.10 b	28.81 c	21.00 bc	25.18 b	5.93 ab	7.11 ab
Yeast at 6g/l (D)	27.50 ab	28.00 b	25.36 b	26.73 cd	23.57 b	24.81 b	6.07 a	6.38 b
A + B	26.33 b	28.36 b	28.67 ab	34.56 b	21.39 bc	25.80 b	5.80 ab	6.93 b
A + C	30.51 a	33.73 a	32.41 a	39.28 a	27.90 a	33.84 a	6.73 a	8.12 a
A + D	28.50 ab	31.28 ab	30.63 a	37.00 ab	26.33 a	31.30 ab	6.50 a	7.73 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

These results could be interpreted and discussed as done before in case of vegetative growth, as previously mentioned. Moreover, they were in well agreement with those results gained by Poole and Chase (1987) on Spathiphyllum cv. Mauna Loa, Broschat (2006) on "Jetty" spathiphyllum and Abdel-Fattah *et al.,* (2009) on *Brassaia actinophylla.*

3- Flowering:

Data averaged in Table (3) exhibit that flowering stalk length (cm) of the fertilized plants was significantly increased due to spraying with active dry yeast only at the rates of 4 and 6g/l, as well as the three combined treatments, which gave higher means than the yeast treatments in the two seasons. The mixture of NPK at 2g/pot and yeast at 2g/l slightly improved such trait with non-significant differences in both seasons. However, the combination of 2g/pot NPK mixture + 4g/l active dry yeast, recorded, in general the utmost high means comparing with the individual and other combined treatments in the two seasons.

Table (3) Effect of fertilization treatments on flowering of *Spathiphyllum wallisii* Schott plants during 2009 and 2010 seasons.

Treatments	Flowering stalk length (cm)		Spathe length (cm)		Spathe F.W. (g)	
	2009	2010	2009	2010	2009	2010
Control	5.33 e	5.73 e	2.00 d	2.33 d	0.97 d	1.30 d
NPK at 2g/pot (A)	6.72 e	7.25 e	3.28 c	3.58 cd	1.60 c	1.97 cd
Yeast at 2g/l (B)	7.10 de	9.33 de	3.07 c	3.00 d	1.48 c	1.65 dc
Yeast at 4g/l (C)	9.56 d	12.76 d	4.21 cb	4.11 c	2.17 bc	2.29 c
Yeast at 6g/l (D)	9.50 d	11.88 d	5.17 b	6.50 b	2.46 b	3.61 b
A + B	12.33 c	16.51 c	5.00 b	5.83 bc	2.39 b	3.25 b
A + C	32.17 a	31.78 a	9.00 a	8.76 a	4.37 a	4.86 a
A + D	18.33 b	23.46 b	7.56 ab	8.10 a	3.64 a	4.52 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

A similar trend was also attained concerning spathe length (cm) and its fresh weight (g), as these two parameters reached also the maximum values due to the combination of NPK mixture at 2 g/pot plus active dry yeast at 4g/l. This may be ascribed to the role of both NPK mixture and yeast in providing the plants with nutrients, proteins, amino acids, fats, glycogen, cellulose and ash required for accelerating growth that reflects afterwards on flowering characteristics.

On the same line, were those results of Maciel *et al.,* (2003) on Spathiphyllum cv. Petite and Desouky (2004) on *Strelitzia reginae.*

4- Some chemical constituents content:

According to data presented in Table (4), it is clear that application of either NPK fertilizer or yeast, as well as their combinations markedly elevated the content of photosynthetic pigments (chlorophylls a, b and carotenoids, as mg/g F.W.) and reduced sugars (mg/g D.W.) in the leaves of treated plants, with the mastery of combined treatment of 2g/pot NPK mixture and 4g/l active dry yeast, which raised these constituents in the leaves to the utmost high averages in the two seasons. This may explain the synergistic effect of NPK mixture and yeast to lump their benefits for supplying the plants luxuriously with some nutrients and vital components that accelerate biosynthesis rate and lead finally to accumulation of more constituents in plant organs.

Such results are in accordance with those of Broschat (2006) on "Jetty" spathiphyllum, Desouky (2004) on bird of paradise and Abdel-Wahed *et al.,* (2006) on *Euonymus japonicus.*

From the aforementioned results, it could be recommended to fertilize one-year-old transplants of *Spathiphyllum wallisii* grown in 20-cm-diameter plastic pots filled with about 2.5 kg of sand, clay and peatmoss mixture (1:1:1, v/v/v) with 2g/pot NPK mixture as a soil drench plus 4g/l active dry yeast as a foliar spray, five times at one month interval to obtain the best growth, flowering and highest quality plants.

Table (4) Effect of fertilization treatments on some chemical constituents content of *Spathiphyllum wallisii* Schott plants during 2009 and 2010 seasons.

Treatments	Chlorophyll a (mg/g F.W.)	Chlorophyll b (mg/g F.W.)	Carotenoids (mg/g F.W.)	Reduced sugars (mg/g D.W.)
Control	1.63	1.33	0.210	0.73
NPK at 2g/pot (A)	2.31	1.75	0.313	1.12
Yeast at 2g/l (B)	1.85	1.58	0.218	0.78
Yeast at 4g/l (C)	2.28	1.95	0.232	0.96
Yeast at 6g/l (D)	2.01	1.98	0.222	1.05
A + B	2.48	2.05	0.351	1.27
A + C	2.63	2.27	0.516	1.43
A + D	2.46	1.96	0.343	1.35

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تحسين كفاءة السماد المركب (NPK) لنبات العلم الأبيض باستخدام الخميرة الجافة النشطة

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أجريت سلسة من تجارب الأصص بإحدى الصوبات الساران (٦٥% ظل) بمشتل معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر خلال موسمي ٢٠٠٩، ٢٠١٠ و ذلك لدراسة تأثير السماد المركب NPK (2:2:1) بمعدلات: صفر، ٢ جم/إصيص كإضافة أرضية، و الخميرة الجافة النشطة بمعدلات: صفر، ٢، ٤، ٦ جم/لتر رشاً على الأوراق، كلٍ على حدة أو في توليفات، و ذلك على النمو، الإزهار و التركيب الكيميائي لشتلات نبات العلم الأبيض (*Spathiphyllum wallisii*) عمر سنة المنزرعة في أصص بلاستيك قطرها ٢٠ سم و مملوءة بحوالي ٢,٥ كجم من مخلوط الرمل، الطين و البيتموس (بنسب حجمية متساوية)، و ذلك عند إضافتها خلال موسم النمو بمعدل خمس مرات و بفاصل شهر بين كل مرتين متتاليتين.

و لقد أوضحت النتائج المتحصل عليها أن جميع معاملات التسميد التي طبقت بهذه الدراسة قد أحدثت زيادة ملحوظة في ارتفاع النبات (سم)، عدد الأوراق/نبات، مساحة الورقة (سم^2)، طول الجذر (سم)، عدد الجذور/نبات و كذلك الوزن الطازج و الجاف للأوراق و الجذور بفروق معنوية مختلفة عند مقارنتها بالكنترول بكلا الموسمين. و لقد زاد أيضاً طول الحامل الزهري و طول الاغريض (سم) و الوزن الطازج لها. كما حدثت زيادة في محتوى الأوراق من كلوروفيللي أ،ب، الكاروتينويدات و السكريات المختزلة. و لقد أدى الجمع بين التسميد بمخلوط الـ NPK و أي مستوى من الخميرة الجافة النشطة إلى حدوث زيادة إضافية في متوسطات جميع القياسات السابقة، بينما كانت السيادة للتوليفة بين مخلوط الـ NPK بمعدل ٢ جم/إصيص و الخميرة الجافة النشطة بمعدل ٤جم/لتر و التي أعطت أعلى القيم على الاطلاق لمعظم القياسات السابقة بكلا الموسمين.

و عليه، فإنه طبقاً لنتائج هذه الدراسة يمكن التوصية بتسميد شتلات نبات العلم الأبيض (السباثيفيللم) عمر سنة المنزرعة في أصص بلاستيك قطرها ٢٠ سم و مملوءة بحوالي ٢,٥ كجم من مخلوط الرمل، الطين و البيتموس (١:١:١ حجماً) بالتوليفة المكونة من ٢ جم/إصيص مخلوط NPK (كإضافة أرضية) + ٤ جم/لتر خميرة جافة نشطة (رشاً على الأوراق)، بمعدل خمس مرات و بفاصل شهر بين كل مرتين للحصول على أفضل نمو و إزهار و أعلى جودة للنباتات.