IMPROVEMENT OF GROWTH AND QUALITY OF TIFWAY SOD BY ACTOSOL AND BIOFERTILIZERS

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ABSTRACT

A field experiment was carried out at the golf greens of the 6th October City, Giza, Egypt during 2006 and 2007 seasons to examine the effect of dressing with actosol (a humic acid NPK liquid fertilizer) at 20 ml/L. as a foliar spray, nitrobien or biogien (biofertilizers containing *Azotobacter chroococcum* and *Azospirillum sp.*., respectively) at 50 g/m^2 for each as a soil drench, and the combined treatments between 20ml/L actosol and 50 g/m^2 of either nitrobien or biogien on growth, density, chemical composition and quality of *Cynodon dactylon* (L.) Pers × *C. transvaalensis* Burtt-Davy hybrid Tifway cultivated in beds (100×100× 30 cm) filled with a mixture of sand and loam (1:1, v/v).

Experimental results indicated that all fertilization treatments significantly increased plant height (cm), density (%), number of plants/m^2, as well as herb fresh and dry weights (g) in both seasons with the superiority of the combination between actosol (20 ml/L.) and biogien (50 g/m^2) followed by the other combination of 20 ml/L actosol + 50g/m^2 nitrobien. A similar trend was also gained concerning the content of chlorophyll a, b and carotenoids (mg/g F.W.) in the leaves, as well as the percentages of total carbohydrates and potassium in the herb. However, the highest percent of nitrogen in the two seasons was recorded by plants fertilized with nitrobien alone at the rate of 50 g/m^2 , but for phosphorus, this was found due to the two combined treatments and also to spraying with actosol alone at the level of 20 ml/L.

From the previously stated results, it could be concluded that spraying Tifway bermudagrass turf with actosol at 20 ml/L level after each cut plus inoculation with either biogien or nitrobien at the rate of 50g/m^2 is the best way for obtaining good growth and high quality.

Key words: Tifway turf, *Cynodon dactylon* × *C. transvaalensis*, humic acid, actosol, biofertilizers, *Azotobacter, Azospirillum,* vegetative growth, chemical composition.

INTRODUCTION

At present, the importance of lawns increases day after day due to their different uses and benefits for both human and environment. Most grasses, however are being used now for establishment of amenity swards. Among them may be Tifway bermudagrass, a hybrid resulted from *Cynodon dactylon* (L.) Pers × *C. transvaalensis* Burtt-Davy (Fam. Gramineae). It is native to tropical and subtropical areas. So, thrives well in warm or hot weather under full sun. It is a long-lived perennial with a spreading habit of growth and withstands close mowing, forming a compact dense turf suitable for athletic fields, parks and home-lawns (Huxley, 1992).

Sward density, resistance to wear and tear, winter hardiness, greenness during drought or under low temperatures, disease resistance and good colour are the most important characteristics that are considered in the desire of making a turf. However, all these characteristics do not exist in a certain species of grasses, but all of them can be improved by fertilization. Humic acids and biofertilizers are being used now in a wide-scale for production of most horticultural crops, as the formers can provide soil microbs with energy, improve nutrients retention in the soil and enhance the waterholding capacity (Dorer and Peacock, 1997), while the latters contain micro-organisms, which fix atmospheric nitrogen in a free living state, e.g. Azotobacter and Azospirillum (Darwish, 2002). Moreover, Azotobacter secretes some growth promoting factors, e.g. gibberellin, cytokinin-like substances, auxins, as well as some vitamines such as thiamine, riboflavin, pyridoxine, cyanocobolamine, nicotinic and pantothenic acids (Darwish, 2002). Subba Rao (1993) indicated that *Azotobacter chroococcum* synthesize antifungal antibiotics, which gave it additional advantage for the use in the field of bioproduction.

In this regard, Hunter and Butler (2005) reported that humic acid significantly increased fresh and dry weights of *Agrostis stolonifera* herb with improving leaf colour and P content. Nutrients leaching was also minimized when humic acid was applied. Likewise, Mueller and Kussow (2005) indicated that humic acid greatly improved colour and quality of creeping bentgrass and increased soil microbial activity. On seedlings of *Catharanthus roseus*, *Pelargonium hortorum*, *Tagetes patula* and *Viola tricolor*, Evans and Li (2003) revealed that humic acid at 2500 or 5000 mg/L increased lateral root number, lateral root length and dry root weight. Similar observations were also gained by Muscolo *et al.,* (1999) on *Pinus laricio*, Demir *et al.,* (1999) on cucumber, Sanchez-Sanchez *et al* (2002) on lemon and El-Seginy (2006) on young pear and apricot trees.

Concerning the beneficial effects of biofertilizers, Peacock and Daniel (1992) postulated that inoculation with *Azotobacter* or *Azospirillum* greatly improved growth and quality of tall fescue and bermudagrass sods. However, Shahin (2005) stated that fertilizer combinations containing phosphorene (a biofertilizer) slightly enhanced growth, density and colour of Paspalum turf grown in either sandy or loamy soil. On other ornamental and aromatic plants, Rashed (2002) found that biofertilizers induced a significant increment in height and fresh and dry weights of *Anethum graveolens* plants. Hussein (2004) mentioned that phosphorene and rhizobacterene increased height, number of leaves and dry weight of *Iris tingitana* cv. Wedgewood plants, while *Bacillus megatherium* produced the highest chlorophylls content. In addition, El-Sayed and El-Feky (2007) declared that biogien at the rate of 10g/plant improved vegetative and root growth of *Ficus binnendijkii* (Amstel King) plants, as well as the contents of pigments, N,P and K in the leaves. On the same line, were those results of Attia and Abdel-Azeem (2005) on *Lawsonia inermis*, Ahmed *et al.,* (2005) on *Populus nigra* and Sarhan *et al.,* (2007) on jojoba.

The objective of this trial, however, is to find out the effect of fertilization with humic acid liquid fertilizer and biofertilizers or both in combinations on growth, colour and performance of Tifway bermudagrass.

MATERIALS AND METHODS

A field experiment was conducted at the golf greens of The 6th October City, Giza, Egypt during 2006 and 2007 seasons to detect the response of Tifway hybrid plants to some fertilization treatments.

So, 2-cm-long cuttings of *Cynodon dactylon* (L.) Pers × *C. transvaalensis* Burtt-Davy hybrid "Tifway" were planted on April, 1st for both seasons in beds (100 × 100 × 30cm; for length × width × depth) filled with an equal mixture of sand and loam. The physical and chemical analysis of the used sand and loam are shown in Table (1).

Table (1): Some physical and chemical properties of the used soil textures during 2006 and 2007 seasons.

Soil texture	Season	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	2006	89.03	2.05	0.40	8.52	23.00	3.16	7.92	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2007	90.10	1.95	0.50	7.45	22.86	3.74	7.80	19.42	8.33	7.20	0.75	1.60	7.00	27.10
Loam	2006	10.18	46.17	19.53	24.12	35.00	3.38	8.09	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	2007	10.30	46.54	18.88	24.28	33.00	3.51	8.16	18.00	8.95	20.50	0.85	3.65	10.20	34.45

The cuttings (at 200g/bed, as such weight contains about 1200-1300 cuttings) were regularly scattered (as large-sized seeds) on the surface of the beds, then gently pressed with a flat and smooth piece of wood for more contact with the soil mixture, and finally covered with a thin layer (about 0.5 cm) of the same soil mixture. After planting, the beds were daily sprayed with fresh water (about 750-800 ml/bed to wet only the zone in which cuttings are imbedded) using a water cane with fine pores until sprouting, which was completely established within 10 days. The beds were afterwards irrigated once every two days with 2 L. of fresh water/bed until May, 1st, as the following fertilization treatments were monthly applied:

1- No fertilization, referred to as control.

2- Actosol, a humic acid NPK (10:10:10) liquid organic fertilizer was added as a foliar spray after each cut at the rate of 20ml/L.

The constituents of actosol were determined and illustrated in Table (2).

Table (2): Main characteristics of the used liquid fertilizer (Actosol) during 2006 and 2007 seasons.

Components	Value	Components	Value	Components	Value
Humic acid (%)	2.9	EC(dS/m)	59.3	B (mg/L.)	70.00
Organic matter/total solids (%)	42.51	N (%)	10.00	Fe (mg/L.)	900.00
Total humic acids/total solids (g/L.)	165.80	P (%)	10.00	Mn (mg/L.)	90.00
Organic carbon (%)	24.64	K (%)	10.00	Zn (mg/L.)	90.00
C/N ratio	2.46	Ca (%)	0.06	Cu (mg/L.)	90.00
pH	8.20	Mg (%)	0.05		

3- Nitrobien (a biofertilizer which contains a specific strain of *Azotobacter chroococcum* bacteria, Conc. 10^{-7}- 10^{9}/cell) was added as a soil drench after each cut at the rate of 50g/m^2.

4- Biogien (a biofertilizer which contains a specific strain of *Azospirillum sp.* bacteria, Conc. 10^{-7}- 10^{9}/cell) was also added as soil drench after each cut at the rate of 50g/m^2.

5- A combination between actosol (as foliar spray at 20ml/L.) and nitrobien (as soil drench at 50g/m^2).

6- A combination between actosol (as foliar spray at 20ml/L.) and biogien (as soil drench at 50 g/m^2).

After two months from planting (on June, 1st), first cut was handily done with very sharp stainless steel shear to leave stubbles with 1 inch long. Other four cuts were carried out monthly thereafter. Each treatment was replicated three times of one bed each, in a completely randomized design (Mead *et al.,* 1993).

Before each cut in the two seasons, plant height (cm) was recorded, while density % (Mahdi, 1953), number of plants/m^2 and fresh and dry weights (g) of the resulted herb after mowing were

monitored after each cut. However, means of each parameter mentioned above in the five taken cuts were collected and expressed in the tables as an average for all cuts. In fresh leaf samples taken from the last cut, photosynthetic pigments content (chlorophyll a, b and carotenoids, mg/g F.W.) was measured according to the method described by Moran (1982), while in dry samples taken also from the herb of last cut, the percentages of total carbohydrates (Herbert *et al.,* 1976), N, P and K (Jackson, 1973) were assessed. The obtained data were statistically analyzed according to SAS program (1994) using Duncan's Multiple Range Test (1955) for verifying the significant differences among means of various treatments.

RESULTS AND DISCUSSION

Effect of fertilization treatments on:

1. Vegetative growth traits:

It is clear from data presented in Tables (3 and 4) that plant height (cm), density (%), number of plants/m^2 and herb fresh and dry weights (g) of Tifway bermudagrass plants were significantly increased in most cases of the two seasons as a result of treated with the various fertilization treatments employed in this study, with the superiority of the combined treatment between actosol at 20ml/L and biogien at 50g/m^2, which gave in general the utmost high means in all vegetative growth parameters, followed by the other combined one between 20ml/L actosol and 50 g/m^2 nitrobien, and then actosol alone at the rate of 20ml/L.

Table (3) Effect of fertilization treatments on plant height, density and number of plants/m^2 of *Cynodon dactylon* x *C. transvaalensis* hybrid (Tifway) (L.) Pers. plants during 2006 and 2007 seasons

Treatments	Plant height (cm)		Density (%)		No. plants/m^2	
	2006	2007	2006	2007	2006	2007
Control	4.01 f	3.80 e	78.26 d	75.98 d	1187.00 f	1146.33 f
Humic acid at 20ml/L (A)	8.10 c	7.62 cd	85.33 c	86.76 c	1298.55 c	1307.35 c
Nitrobien at 50g/m^2 (B)	6.80 e	6.63 d	83.70 cd	84.12 cd	1273.74 d	1268.44 d
Biogien at 50g/m^2 (C)	7.70 d	7.82 c	82.41 dc	83.10 dc	1261.38 e	1253.42 e
A+B	8.42 b	8.34 b	91.80 b	93.68 b	1579.00 b	1476.38 b
A+C	8.86 a	8.99 a	96.75 a	97.47 a	1718.76 a	1568.63 a

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

Application of nitrobien or biogien individually at the level of 50g/m^2 for each improved also the vegetative growth, but less than the combined treatments and actosol (humic acid) alone. This may indicate the synergistic effect of humic acid for increasing the availability of nutrients in the soil through influences on soil microbial activity, and biofertilizers, which fix more atmospheric nitrogen and secrete more vitamines and growth promoting substances, especially in the presence of humic acid.

Table (4) Effect of fertilization treatments on fresh and dry weights of *Cynodon dactylon* x *C. transvaalensis* hybrid (Tifway) (L.) Pers. herb during 2006 and 2007 seasons

Treatments	Fresh weight (g)		Dry weight (g)	
	2006	2007	2006	2007
Control	56.27 e	54.33 e	16.88 e	16.23 e
Humic acid at 20ml/L (A)	106.63 c	107.90 c	43.52 c	44.92 c
Nitrobien at 50g/m^2 (B)	87.96 d	88.03 d	33.45 d	33.74 d
Biogien at 50g/m^2 (C)	84.37 ed	85.46 ed	32.07 d	32.50 d
A+B	132.68 b	130.50 b	52.80 b	52.00 b
A+C	142.70 a	140.17 a	58.16 a	56.13 a

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

Similarly were those results of Peacock and Daniel (1992) on tall fescue and Bermudagrass, Hunter and Butler (2005) on *Agrostis stolonifera*, Shahin (2005) on *Paspalum vaginatum*, Ahmed *et al*., (2005) on *Populus nigra* and El-Sayed and El-Feky (2007) on *Ficus binnendijkii* (Amstel King).

2. Chemical composition:

According to data averaged in Table (5), it is evident that application of actosol, nitrobien and biogien individually or in combination induced a significant increment in the leaf content of chlorophyll a, b and carotenoids (mg/g F.W.) over control plants in the two seasons.

Table (5) Effect of fertilization treatments on pigments content (mg/g F.W.) in the leaves of *Cynodon dactylon* x *C. transvaalensis* hybrid (Tifway) (L.) Pers. plants during 2006 and 2007 seasons

Treatments	Chlorophyll a		Chlorophyll b		Carotenoids	
	2006	2007	2006	2007	2006	2007
Control	0.707 e	0.896 e	0.371 e	0.422 e	0.417 e	0.451 e
Humic acid at 20ml/L (A)	1.018 c	1.133 c	0.440 c	0.521 c	0.598 c	0.689 c
Nitrobien at 50g/m^2 (B)	0.998 d	1.037 d	0.409 d	0.490 d	0.446 d	0.523 d
Biogien at 50g/m^2 I	0.999 d	1.042 d	0.410 d	0.499 d	0.451 d	0.530 d
A+B	1.356 b	1.310 b	0.561 b	0.603 b	0.724 b	0.821 b
A+C	1.429 a	1.450 a	0.628 a	0.711 a	0.801 a	0.900 a

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

The mastery however was for combined treatments, especially between 20ml/L actosol and 50g/m^2 biogien, as such combination recorded the highest content of various pigments in the leaves giving the best greenness at all. It was also noticed that pigments content in the leaves of plants fertilized with nitrobien or biogien alone were closely near together in both seasons and thus, were in the same rank of significancy, while actosol alone gave higher contents. This may indicate the role of actosol (humic acid) in increasing the soil water holding capacity, improving soil structure, enhancing the metabolic activity of microorganisms and acting as a source of N, P and S for plants (Higa and Wididana, 1991).

A similar trend was also gained with regard to the percentages of total carbohydrates and potassium in the two seasons (Table, 6), whereas the highest percent of nitrogen in both seasons was obtained when the plants was dressed with nitrobien alone at the rate of 50 mg/m^2. This may be due to the high ability of *Azotobacter chroococcum* bacteria in fixing the atmospheric N more than *Azospirillum sp.* ones. The highest means of P % in the two seasons, on the other hand, was found due to the spraying with the combined treatments and actosol (humic acid) alone at the level of 20ml/L. This may refer to the role of humic acid in reducing the phosphate fixing capacity of the soil (Heng, 1989).

Table (6) Effect of fertilization treatments on total carbohydrates, N, P and K percentages in the herb of *Cynodon dactylon* x *C. transvaalensis* hybrid (Tifway) (L.) Pers. plants during 2006 and 2007 seasons

Treatments	Total carbohydrates		N		P		K	
	2006	2007	2006	2007	2006	2007	2006	2007
Control	36.43e	38.25e	1.38d	1.52d	0.58c	0.53c	1.13c	1.28d
Humic acid at 20ml/L (A)	52.35c	55.00c	1.86c	2.01cd	0.97a	1.09a	1.74b	1.69c
Nitrobien at 50g/m^2 (B)	48.79d	51.22d	2.18a	2.43a	0.67b	0.63b	1.17c	1.36d
Biogien at 50g/m^2 I	47.56d	49.87d	1.96bc	2.16cb	0.61b	0.59b	1.16c	1.31d
A+B	61.98b	63.18b	2.00b	2.08c	0.98a	1.07a	1.79b	1.83b
A+C	70.33a	74.21a	2.16a	2.27b	1.00a	1.10a	2.11a	2.20a

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

The aforementioned findings are in harmony with those attained by Mueller and Kussow (2005) on creeping bentgrass, Muscolo *et al.,* (1999) on *Pinus laricio*, Hussein (2004) on *Iris tingitana* cv. Wedgewood and Sarhan *et al.,* (2007) who mentioned that the highest total carbohydrates, N, K, Cu and Mn in the different parts mf jojoba plant were recorded by spraying Biomagic at 10g/L in the presence of Azotobacter and Bacillus mixture.

According to the previous results, it could be recommended to spray Tifway bermudagrass turf with actosol (a humic acid liquid fertilizer) at the rate of 20 ml/L after each cut plus inoculation with either biogien or nitrobien at the rate of 50g/m^2 for obtaining the best growth, good colour and high quality.

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تحسين نمو و جودة مسطح التيف واي بالأكتوسول و الأسمدة الحيوية

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معهد بحوث البساتين-مركز البحوث الزراعية- الجيزة- مصر.

أجريت تجربة حقلية بملاعب الجولف بمدينة السادس من أكتوبر، الجيزة، مصر خلال موسمي ٢٠٠٦ ، ٢٠٠٧ و ذلك لدراسة تأثير التسميد بالأكتوسول (سماد سائل لحمض الهيوميك) بمعدل ٢٠ مل/لترشا على الأوراق، النيتروبين أو البيوجين (أسمدة حيوية يحتوي فيها الأول على بكتريا *Azotobacter chroococcum* بينما يحتوي الثاني على بكتريا *Azospirillum sp.*) كلٌ على حدة بمعدل ٥٠جم/م^2 تكبيشاً للأرض، و كذلك المعاملات المشتركة بين الأكتوسول (٢٠ مل/لتر) و كلٍ من النيتروبين أو البيوجين (٥٠ جم/م^2) على النمو، الكثافة و التركيب الكيميائي و الجودة لمسطح هجين البرمودا (تيف واي) *Cynodon dactylon* (L.) Pers X *C. transvaalensis* Burtt-Davy hybrid (Tifway) و المنزرع في أحواض أبعادها ١٠٠×١٠٠×٣٠ سم ملأت بمخلوط متساوي من الرمل و الطمي.

و لقد أوضحت النتائج المتحصل عليها أن جميع معاملات التسميد موضع الدراسة قد أحدثت زيادة معنوية في ارتفاع النبات (سم)، الكثافة (%)، عدد النباتات/م٢ و الوزن الطازج و الجاف للعشب الناتج بعد القص، مع تفوق المعاملة المشتركة بين الأكتوسول بمعدل ٢٠ مل/لتر و البيوجين بمعدل ٥٠ جم/م^2 ، حيث سجلت هذه المعاملة أعلى المتوسطات، تليها المعاملة المشتركة الأخرى بين الأكتوسول و النيتروبين. و لقد أمكن الحصول على اتجاه مشابه فيما يتعلق بمحتوى الأوراق من كلوروفيللي أ، ب و الكاروتينويدات، و كذلك محتوى العشب من الكربوهيدرات الكلية و البوتاسيوم. أما أعلى نسبة مئوية للأزوت في كلا الموسمين فقد سجلتها النباتات التي سمدت بالنيتروبين بمفرده بمعدل ٥٠جم/م^2 ، بينما أعلى نسبة مئوية من الفوسفور سجلته النباتات التي عوملت بالمعاملات المشتركة و كذلك التي رشت بالأكتوسول بمفرده بمعدل ٢٠ مل/لتر.

من هذه النتائج يمكن النصح برش مسطح هجين البرمودا (تيف واي) بالأكتوسول بمعدل ٢٠ مل/لتر عقب كل حشة + التسميد بالبيوجين أو النيتروبين بمعدل ٥٠جم/م^2 تكبيشاً للأرض يعتبر أفضل سبيل لتحقيق أحسن نمو و أعلى جودة لهذا المسطح.