10th Conf. Agric. Dev. Res., Fac. Agric., Ain Shams Univ., Cairo, Egypt, 2006
Annals Agric. Sci., Sp. Issue, 1, 65 -83, 2006

GROWTH AND FORAGE PRODUCTION OF *PHALARIS CANARIENSIS* L. AS AFFECTED BY SHEEP MANURE, BIOFERTILIZER AND CUTTING HEIGHT UNDER CALCAREOUS SOIL CONDITIONS

[6]

El-Toukhy[1], Salwa A. and Hoda H. Abdel-Azeem[2]

ABSTRACT

This investigation was carried out in calcareous soil at Mariout Research Station, Desert Research Center (D.R.C.) during 2003/04 and 2004/05 seasons to study the effect of two cutting heights (10 and 20 cm above the ground surface), three levels of organic manure (0.0, 20 and 40 m^3/fed.) and four levels of biofertilizers (without inoculation, phosphate dissolving bacteria (PDB), nitrogen fixing bacteria (NFB) including *Azotobacter* & *Azospirillum* and multibiofertilizer consisting of NFB + PDB on some vegetative growth and forage yield characters of reed canary grass. Data obtained indicated that plant height, leaf area/plant No. of leaves/unit, No. of tillers/unit and leaf/stem ratio were affected significantly by cutting height. The fresh and dry forage yields of whole plant and its parts i.e. leaves and stems were significantly decreased in the first cut of both seasons by increasing cutting height. However, in the second cut of the second season the fresh and dry yields of whole plant, its parts and the accumulated yield were increased by raising cutting height. Applying organic manure increased all growth parameters and this reflected on increasing the forage yield. Inoculating reed canary grass with (PDB), (NFB) and (NFB + PDB) enhanced most of growth parameters studied and forage yield traits under calcareous soil conditions of Mariout district. Microbiological analysis of soil samples in the different treatments indicated that application of multibiofertilizer containing NFB and PDB together with organic manure markedly increased the microbial activity in plant rhizosphere region.

Key words: *Phalaris canariensis*, Organic manure, Multi-biofertilizers, Reed canary grass, Nitrogen fixing bacteria, Phosphate dissolving bacteria.

INTRODUCTION

Under newly reclaimed lands, many crops failed to grow well so, the choice of the cultivated crops is very important. Reed Canary grass (*Phalaris canariensis* L.) is considered one of the most drought-tolerant of the cool-season grasses. It can be used for pasture or in mixture with legume for hay and silage.

The higher prices of mineral fertilizer and the concern of pollution of water and

1- Range Management Unit, Desert Research Center, Matariya, Cairo, Egypt
2. Soil Microbiology Unit, Desert Research Center, Matariya, Cairo, Egypt

(Received August 27, 2006)
(Accepted September 23, 2006)

the atmosphere, the interest in the use of organic manure and biofertilizers is being renewal specially in the developing countries.

Organic manure affects crop growth and yield, either directly by supplying nutrients or indirectly by modifying soil physical properties. In this respect, many researchers studied this effect on each of growth or yield of many crops (**Studdy *et al* 1995**) on reed canary grass, **Patel *et al* 1996** on Brassica juncea, **El-Toukhy, 1997** on barley, **Rizk *et al* 2000** on reed canary grass and **Mowafy, 2002** on wheat plant).

Biofertilizers are an environmental and natural source of non-bulky, low-cost organic farm input. The application of associative nitrogen fixing bacteria was investigated by **El-Toukhy (1997)**; **Tripathi *et al* (1998)**; **Mashhoor *et al* (2000)** and **Rizk *et al* (2000)**. The favourable effect of phosphate dissolving bacteria on the yield and characters of different plants grown in calcareous soils has been reported by **Abdel-Maksoud *et al* (1982)**; **El-Toukhy (1997)**; **Abdel-Azeem & El-Toukhy (2000)**; **El-Toukhy and Abdel-Azeem (2000)**

Concerning the effect of cutting height, many researchers discussed this point, **El-Houssini (1999)**; **Gaber (2002)** and **Essa & Rawi (2003)** revealed that raising stubble height caused a significant increase of most growth parameters, dry matter and digestible organic matter yield.

So, the main target of this study is to evaluate the effect of cutting height, organic manure and different biofertilizer treatments on growth and forage productivity of reed canary grass under calcareous soil conditions at Mariout region.

MATERIALS AND METHODS

Two field experiments were set up at Mariut Research Station, Desert Research Center during two successive seasons, i.e., 2003/2004 and 2004/2005. Soil of the experimental location was subjected to mechanical and physicochemical analysis according to **Jackson (1958)**. It was characterized as sandy clay loam texture with about 47.1% calcium carbonate, 0.27% organic matter, pH 8.4 and electrical conductivity 2.97 dSm^{-1}.

The experiments included 24 treatments represent the combinations of two clipping heights (10 and 20 cm above ground surface), three levels of organic manure (0, 20 and 40 m^3 fed^{-1}) and four biofertilization treatments (without grains inoculation, inoculation by phosphate dissolving bacteria PDB, inoculation by nitrogen fixing bacteria NFB and inoculation by PDB + NFB.

Sheep dung was applied during soil preparation for organic manuring. Its chemical analysis (**Jackson, 1958**) was found to be; 60.9% moisture, 19.34% organic carbon, 34.17% organic matter and 1.45% total nitrogen.

Biofertilization was carried out using *Bacillus megaterium* as phosphate dissolving bacteria and *Azotobacter chroococcum* + *Azospirilum lipoferum* as nitrogen fixing bacteria. The above bacterial cultures, were provided from Soil Microbiology Unit, Desert Research Center, Cairo, having the ability to withstand stress soil conditions (**Abdel-Azeem 1998**). They were grown separately on modified Bunt and Rovira medium (**Taha *et al* 1969**) modified Ashby's medium (**Abdel-Malek and Ishac, 1968**) and malate medium (**Dobereiner, 1978**), respectively. The biofertilizer liquid culture inoculants (10^8 cells ml^{-1}) were mixed with plant seeds. Carboxy methyl cellulose 16% was added to the liquid cultures, before seed dressing, as an adhesive agent.

The experimental design was split-split plot design with four replications where clipping heights occupied the main plots. Organic manure treatments allocated in the sub-plots and the four treatments of biofertilizers were distributed in the sub-sub- plots in a random manner. The plot area 2 X 2.5 m consisted of four ridges. Grains of seed canary grass (*Phalaris canarensis* L.) commercial variety, were sown in each hill at one side on 4^{th} and 5^{th} December 2003-2004 and 2004-2005 growing seasons respectively, with seeding rate of 12 kg fed^{-1}. Three cuts were taken at both seasons, the first cut was taken after 60 and 90 days from sowing at both seasons respectively. The second cut was taken after the first cut by 30 days, while the third cut was taken after the second one by 45 days for both seasons. The delay in the first cut of the second season was due to the severe weather at that year which reflected to the plants growth. The relative humidity was above its normal and it was a chance to form frost, the severe wind caused sand storm and the air temperature was below its normal degree (according to Meteorological parameter).

Growth and yield determinations:

Samples of ten surrounding plants were chosen randomly from each experimental units before each cut to study plant height from soil surface up to the tip end of the plant. Numbers of leaves and number of tillers/unit area were determined. Leaf area (cm^2)/plant, the third leaf from the top were determined by leaf area meter, specific leaf weight, SLW (mg/cm^2) and leaf/stem ratio were determined on dry weight basis.

All plants of each experimental unit (5 m^2) were clipped to determine fresh and dry forage yields of leaves, stems, whole plant and the accumulated fresh and dry yields/season (ton/fed).

Microbiological determinations

Samples of plant rhizosphere were taken at three cutting times and subjected to microbial determination of heterotrophic plate count (total microbial count) on soil extract agar (**Page *et al* 1982**), phosphate dissolving bacterial count on Bunt and Rovira agar medium after modification by **Taha *et al* (1969)**, counts of *Azotobacter* on modified Ashby's medium (**Abdel-Malek and Ishac, 1968**), counts of *Azospirillum* on semi-solid malate medium (**Dobereiner, 1978**).

Data obtained were statistically analysed using the Costat computer program according to the method described by **Snedecor and Cochran (1980)**. The differences between means were tested by **Duncan (1955)**. Means having the same alphabetical letters were not significantly different.

RESULTS AND DISCUSSION

I. Growth characters and plant yield

1. Effect of Biofertilizer

Inoculated reed canary grains with phosphate dissolving bacteria (PDB) enhanced leaf / stem ratio and plant height. These finding hold fairly true and significant at third cut of the first season and second cut of the second one respectively (Table 1). This indicates that inoculation with (PDB) encouraged production of more leaves/stems with more extension and covered more ground surface area with more elongation. At the same time, it was noticed that inoculation with nitrogen fixing bacteria (NFB) increased number of leaves/unit and specific leaf weight. Such increment reached the significant level at the second and first cuts of the first season respectively. Specific leaf weight (SLW) of reed canary grass also reached to its highest value in response to inoculation with multibiofertilizer (PDB + NFB) in the third cut of the first season.

However, it could be concluded that PDB, NFB or (PDB + NFB) enhanced most of growth parameters. This result may be attributed to the role of microorganisms in converting the insoluble phosphate in soil into soluble form by secreting organic acids which lower the pH and bring about the dissolution of bound forms of phosphate. Some hydroxy acids may chelate with calcium and iron resulting in effective solubilization and utilization of phosphates (**Boutroes *et al* 1987**). The enhancement effect may be also due to the role of nitrogen fixing bacteria in enriching soil with that essential element and increasing its availability to face plant requirements (**Hernandez *et al.* 1994**). These results are in agreement with those obtained by **El-Toukhy (1997)** on barley plants, **Abdel-Azeem and El-Toukhy (2000)** on ryegrass, **El-Toukhy and Abdel-Azeem (2000)** on barley and **Rizk *et al* (2000)** on reed canary grass.

Concerning forage production of reed canary grass, data presented in **Table (2)** show that fresh and dry leaves as well as total dry yield were increased as inoculated grains by PDB comparing to uninoculated one. Such increases were observed at third and first cut of the first season respectively. At the same time fresh leaves, spikes and the accumulated fresh or dry yield followed closely the same previous trend. These increases were obtained at third cut of the second season. In general, it could be concluded that inoculated reed canary grains with PDB enhanced the whole plant and its parts as well as the net accumulated yield. In this respect **El-Toukhy and Abdel-Azeem (2000)** and **Estefanous and Sawan (2003)** reached to almost the same conclusion. On the other hand, NFB or mixture of NFB + PDB played an important role for increasing the productivity herein. Fresh and dry stems as well as total dry yield significantly increased under the above mentioned treatments. This increase was detected at third cut of the first season. The same trend followed closely for dry leaves yield, stems fresh and dry, total fresh and dry yield and the net accumulated fresh and dry. This trend was obtained at the first cut of the second season. It could be concluded that NFB or mixture of NFB + PDB enhanced the productivity of reed canary grass under the conditions of Mariout region. These finding are in general in accordance with those obtained by **Ishac *et al* (1986)** and **Mashhoor *et al* (2000)**.

2. Effect of organic manure

The influence of sheep dung manure on some growth parameters is shown in **Table (1)**. Increasing organic manure (O.M) caused a significant increase for number of tillers, number of leaves and leaf area. Such increases were observed at second cut of the first season. Also, plant

Table 1. Some growth parameters of reed canary grass as influenced by cutting intensity, organic manure and biofertilizers treatments in 2003/04 and 2004/05 growing seasons.

Traits / Treatment		2003/2004								
		PH (cm)			No. T/unit			No. L./unit		
		No. of cut			No. of cut			No. of cut		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Bio-fertilizer	Without	52.9a	74.2a	90.1a	47.9a	63.0a	121.6a	188a	318ab	575a
	PDB	55.2a	74.6a	87.9a	49.1a	59.6a	95.0a	199a	319ab	439b
	NFB	54.7a	76.0a	90.7a	48.4a	66.3a	102.6a	189a	349a	505ab
	(PDB+NFB)	51.1a	73.5a	91.6a	42.0a	58.4a	91.8a	165a	300b	471ab
Organic manure (m^3 Fd.)	0	51.8b	72.4a	90.7ab	46.6a	61.4ab	98.7a	184a	295b	473a
	20	56.2a	76.2a	87.4b	48.2a	65.8a	93.5a	187a	340a	473a
	40	52.5b	74.3a	92.2a	45.8a	58.3b	116a	184.5a	329ab	547a
Cutting height (cm)	10	53.1a	73.2a	83.4b	48.4a	64.3a	91.0b	188a	328a	450b
	20	53.8a	75.4a	96.8a	45.3a	59.4a	114.5a	183a	314a	545a
		2004/2005								
Biofertilizer	Without	71.7a	73b	59.5a	54.7a	35.4a	34.7a	2.86a	165a	154a
	PDB	70.8a	81.5a	61.2a	59.9a	37.5a	36.6a	306a	186a	157a
	NFB	76.8a	70.2b	60.2a	62.3a	40.9a	36.7a	310a	188a	236a
	(PDB+NFB)	78.3a	73.6b	59.1a	55.3a	42.3a	32.5a	268a	192a	133a
Organic manure (m^3/fed.)	0	70.2b	74.7a	57.7b	59.8a	42.1a	36.8a	288ab	193a	220a
	20	78.6a	75.8a	62.0a	60.6a	39.3a	38.5a	329a	182a	168a
	40	74.4ab	73.3a	60.5ab	53.8a	35.7a	30.1b	260b	172a	122a
Cutting height (cm)	10	69.5b	65.4b	59.4a	62.1a	42.4a	35.6a	335a	199a	153b
	20	79.3a	83.7a	60.7a	53.9b	35.7a	34.6a	250b	167a	188a

P.H = Plant height LA = Leaf Area S.L.W. = Specific leaf weight No. T/unit = No. of tillers/unit
No. L./unit = No. of leaves/unit L/S ratio = Leaf stem ratio PDB = Phosphate dissolving bacteria
NFB = Nitrogen fixing bacteria.
Means having the same alphabetical letters are not significantly different

Table 1. Cont.

Traits / Treatment		L.A. (cm)^2 No. of cut 1st	2nd	3rd	S.L.W (mg/cm^2) No. of cut 1st	2nd	3rd	L/S ratio No. of cut		
2003/2004										
Bio-fertilizer	Without	27.0a	25.1a	5.3ab	0.003ab	0.0036a	0.0063b	33.05a	2.09a	0.656b
	PDB	28.1a	25.7a	5.6a	0.0029b	0.0037a	0.0065ab	17.9b	1.91a	1.05a
	NFB	26.8a	26.1a	5.1ab	0.0031a	0.0034a	0.0065ab	20.4b	1..9a	0.613b
	(PDB+NFB)	26.2a	25.3a	4.6b	0.0031a	0.0036a	0.0069a	18.7b	1.87a	0.587b
Organic manure (m^3 Fd.)	0	26.0a	24.4b	4.9a	0.003a	0.0038a	0.0066a	23.05b	2.07a	0.694zb
	20	26.7a	27.0a	5.3a	0.0029a	0.0035ab	0.0065a	13.02c	1.89a	0.934a
	40	28.3a	25.2ab	5.2a	0.0031a	0.0034b	0.0066a	32.05a	1.87a	0.551b
Cutting height (cm)	10	25.5b	26a	5.0a	0.003a	0.0035a	0.0067a	20.5a	1.75b	0.805a
	20	28.5a	25a	5.3a	0.003a	0.0036a	0.0064a	9.9b	2.14a	0.648b
2004/2005										
Biofertilizer	Without	33.7a	31.5a	5.7a	0.0043a	0.023a	0.006a	2.44a	0.924a	0.305a
	PDB	33.0a	39.3a	5.5a	0.0039a	0.019a	0.006a	2.39a	0.86a	0.341a
	NFB	33.6a	27.5a	5.9a	0.0041a	0.019a	0.006a	2.29a	00981a	0.298a
	(PDB+NFB)	36.0a	28.2a	5.9a	0.0040a	0.020a	0.006a	2.17a	0.932a	0.375a
Organic manure (m^3/fed.)	0	33.0a	29.5a	5.4a	0.0041a	0.020a	0.006a	2.42a	0.881a	0.341a
	20	36.3a	30.0a	5.9a	0.0039a	0.019a	0.0059a	2.16a	0.96a	0.298a
	40	32.9a	29.5a	6.0a	0.0043a	0.021a	0.006a	2.38a	0.931a	0.350a
Cutting height (cm)	10	32.8a	29.2a	6.2a	0.0041a	0.019a	0.006a	1.829b	1.056a	0.338a
	20	35.5a	30.1a	5.4a	0.0040a	0.022a	0.006a	2.809a	0.792b	0.321a

P.H = Plant height LA = Leaf Area S.L.W. = Specific leaf weight No. T/unit = No. of tillers/unit
No. L./unit = No. of leaves/unit L/S ratio = Leaf stem ratio
PDB = Phosphate dissolving bacteria
NFB = Nitrogen fixing bacteria.
Means having the same alphabetical letters are not significantly different.

Table 2. Reed canary grass forage yield and its components as influenced by cutting intensity, organic manure and biofertilizer treatments in 2003/2004 and 2004/2005 growing seasons

Treatment	Traits	2003/2004					
		Leaves fresh (t./fed)			Stems fresh (t./fed)		
		No. of cut			No. of cut		
		1st	2nd	3rd	1st	2nd	3rd
Bio-fertilizer	Without	0.758a	1.634a	0.92b	0.075a	0.999a	1.811ab
	PDB	0.796a	1.953a	1.162a	0.058a	1.237a	1.718b
	NFB	0.786a	1.552a	0.911b	0.082a	1.042a	1.909ab
	(PDB+NFB)	0.739a	1.641a	0.948a	0.080a	1.252a	2.25a
Organic manure (m^3 Fd.)	0	0.806a	1.735a	0.972ab	0.088a	1.059a	2.037a
	20	0.764a	1.724a	1.120a	0.07a	1.216a	1.708b
	40	0.739a	1.627a	0.864b	0.064a	1.123a	2.021a
Cutting height (cm)	10	0.810a	1.654a	0.884b	0.121a	1.18a	1.913a
	20	0.729a	1.736a	1.087a	0.026b	1.085a	1.931a
		Leaves dry (T/Fed.)			Stems dry (T/fed.)		
Biofertilizer	Without	0.112b	0.247a	0.278a	0.013a	0.169a	0.449ab
	PDB	.129a	0.326a	0.252a	0.063a	0.189a	0.343b
	NFB	0.111b	0.242a	0.311a	0.095a	0.133a	0.528a
	(PDB+NFB)	0.110b	0.269a	0.321a	0.098a	0.167a	0.563a
Organic manure (m^3/fed.)	0	0.117a	0.28a	0.300ab	0.013a	0.184a	0.462a
	20	0.120a	0.278a	0.319a	0.008a	0.159a	0.474a
	40	0.108a	0.254a	0.252b	0.0079a	0.151a	0.476a
Cutting height (cm)	10	0.123a	0.256a	0.309a	0.016a	0.183a	0.487a
	20	0.107b	0.286a	0.271a	0.003b	0.146a	0.454a

The same footnote as presented in Table (1)

Table 2. Cont.

Treatment / Traits		Spikes fresh (t./fed.) No. of cut 1st	2nd	3rd	Total fresh (t./fed.) No. of cut 1st	2nd	3rd	Accumulated dry (T/fed.)
		2003/2004						
Bio-fertilizer	Without	-	-	0.56a	0.833a	2.633a	3.291a	6.757a
	PDB	-	-	0.291b	0.854a	3.191a	3.171a	7.216a
	NFB	-	-	0.388ab	0.868a	2.595a	3.208a	6.671a
	(PDB+NFB)	-	-	0.415a	0.819a	2.892a	3.613a	7.324a
Organic manure (m^3 Fd.)	0	-	-	0.334b	0.896a	2.794a	3.343a	7.033a
	20	-	-	0.522a	0.831a	2.94a	3.35a	7.121a
	40	-	-	0.382b	0.803a	2.75a	3.27a	6.823a
Cutting height (cm)	10	-	-	0.355a	0.931a	2.83a	3.152a	6.917a
	20	-	-	0.472a	0.752b	2.82a	3.49a	7.063a
		Spikes dry (T/fed.)			Total dry (T/fed.)			Accumulated dry (T/fed.)
Biofertilizer	Without	-	-	0.221a	0.125b	0.416a	0.948ab	1.489a
	PDB	-	-	0.187a	0.135a	0.515a	0.782b	1.432a
	NFB	-	-	0.278a	0.121b	0.375a	1.117a	1.613a
	(PDB+NFB)	-	-	0.268a	0.119b	0.436a	1.152a	1.707a
Organic manure (m^3/fed.)	0	-	-	0.234a	0.13a	0.464a	0.996a	1.59a
	20	-	-	0.263a	0.128a	0.437a	1.056a	1.621a
	40	-	-	0.219a	0.116a	0.405a	0.947s	1.468a
Cutting height (cm)	10	-	-	0.242a	0.139a	0.439a	1.038a	1.616a
	20	-	-	0.234a	0.110b	0.432a	0.959a	1.501a

The same footnote as presented in Table (1)

Table 2. Cont.

Treatment	Traits	2004/2005					
		Leaves fresh (t./fed)			Stems fresh (t./fed)		
		No. of cut			No. of cut		
		1st	2nd	3rd	1st	2nd	3rd
Bio-fertilizer	Without	3.986a	1.492ab	0.145b	2.335b	2.3a	0.646a
	PDB	4.065a	1.706a	0.207a	2.546ab	2.44a	0.72a
	NFB	5.512a	1.287ab	0.207a	2.801ab	1.803a	0.731a
	(PDB+NFB)	4.327a	1.12b	0.216a	3.081a	1.964a	0.780a
Organic manure (m^3 Fd.)	0	3.641b	1.45a	0.205a	2.224b	2.209a	0.687ab
	20	4.522a	1.302a	0.199a	3.147a	2.124a	0.832a
	40	4.505a	1.452a	0.177a	2.70b	2.049a	0.638b
Cutting height (cm)	10	4.319a	1.034b	0.225a	3.186a	1.269b	0.806a
	20	4.26a	1.769a	0.163b	2.195b	2.986a	0.632a
		Leaves dry (T/Fed.)			Stems dry (T/fed.)		
Biofer-tilizer	Without	0.587b	0.397a	0.065a	0.266b	0.497a	0.23a
	PDB	0.639ab	0.42a	0.085a	0.286ab	0.528a	0.276a
	NFB	0.699a	0.384a	0.078a	0.325a	0.458a	0.264a
	(PDB+NFB)	0.631ab	0.0381a	0.082a	0.326a	0.477a	0.251a
Organic manure (m^3/fed.)	0	0.579b	0.37a	0.08a	0.269b	0.477a	0.255ab
	20	0.675a	0.38a	0.076a	0.336a	0.487a	0.288a
	40	0.663a	0.436a	0.07a	0.297ab	0.505a	0.223b
Cutting height (cm)	10	0.631a	0.247b	0.085a	0.357a	0.264b	0.273a
	20	0.647a	0.544a	0.069	0.244b	0.715a	0.238a

The same footnote as presented in Table (1)

Table 2. Cont.

Treatment \ Traits		2003/2004						
		Spikes fresh (t/fed.)			Total fresh (t./fed.)			Accumu-lated dry (T/fed.)
		No. of cut			No. of cut			
		1st	2nd	3rd	1st	2nd	3rd	
Bio-fertilizer	Without	-	0.439a	0.293b	6.321b	4.286a	1.085a	11.692b
	PDB	-	0.351a	0.444a	6.61ab	4.501a	1.371a	12.482a
	NFB	-	0.320a	0.362ab	7.313a	3.41a	1.301a	12.024a
	(PDB+NFB)	-	0.335a	0.365ab	7.408ab	3.419a	1.361a	12.188a
Organic manure (m^3 Fd.)	0	-	0.442a	0.382a	5.865b	4.101a	1.274ab	11.24b
	20	-	0.379ab	0.384a	7.669a	3.805a	1.415a	12.889a
	40	-	0.263b	0.333a	7.205a	3.764a	1.148b	12.117a
Cutting height (cm)	10	-	0.227b	0.415a	7.505	2.53b	1.446	11.481b
	20	-	0.495a	0.318a	6.455	5.25a	1.113	12.818a
		Spikes dry (T/fed.)			Total dry (T/fed.)			Accumu-lated dry (T/fed.)
Biofertil-izer	Without	-	0.124a	0.17a	0.853b	1.018a	0.465a	2.336b
	PDB	-	0.096a	0.236a	0.925ab	1.044a	0.597a	2.567a
	NFB	-	0.102a	0.200a	1.023a	0.944a	0.542a	2.509a
	(PDB+NFB)	-	0.114a	0.202a	0.957ab	0.971a	0.535a	2.463ab
Organic manure (m^3/fed.)	0	-	0.122a	0.215a	0.848b	0.970a	0.551ab	2.369b
	20	-	0.117a	0.212a	1.011a	0.985a	0.576a	2.572a
	40	-	0.088a	0.179a	0.96ab	1.029a	0.472b	2.461ab
Cutting height (cm)	10	-	0.056b	0.225a	0.988a	0.567b	0.584a	2.139b
	20	-	0.162a	0.179a	0.891b	1.422a	0.485a	2.799a

The same footnote as presented in Table (1)

height and leaf/stem ratio followed closely the same previous trend at first and third cut of the first season. At second season, slight increase in growth parameters was obtained as applied O.M except of plant height and No. of leaves increased significantly at first and third cut. In general it could noticed that added 20 m^3 O.M/fed enhanced most of growth parameters of reed canary grass more than 40 m^3/fed under the conditions of Mariout region.

About the productivity, data given in **Table (2)** show that fresh and dry yield of leaves and fresh spikes yield significantly increased under the application of 20 m^3/fed O.M comparing to added 40 m^3/fed. This result was obtained at third cut of the first season. At the same time, fresh and dry yield of leaves, stems and whole plant as well as net accumulation yield take similar trend. Such significant increase hold fairly true at first and third cut of the second season and could be attributed to increasing the nutrients released from the degradation of O.M, supporting the plant with more of its demand which resulted in increasing plant growth (**Devlin, 1984**). Similar results were obtained by **Patel *et al* (1996)** on Brassica juncea, **El-Toukhy (1997)** on barley plants, **Rizk *et al* (2000)** on reed canary grass and **Mowafy (2002)** on wheat.

3. Effect of cutting height

Results presented in **Table (1)** show the effect of cutting height on growth parameters. Raising clipping height from 10 to 20 cm above the ground surface generally caused a significant increase in plant height, number of tillers, number of leaves, leaf area and L/S ratio. Such increases were detected in some cuts of both seasons. On the other hand, a significant increase as decreasing stubble height from 20 to 10 cm above the ground surface for number of tillers, number of leaves and L/S ratio. This trend was obtained at the first and second cuts of the second season. In general, it was noticed a tendency to increase all growth parameters of reed canary grass by raising clipping height from 10 to 20 cm above the ground surface, especially for later cuts.. These results are in line with those reported by **El-Houssini (1999)** on Lolium multiflorum, **Gaber (2002)** on reed canary grass and **Essa and Rawi (2003)** on barley.

Concerning the effect of cutting height on forage yield, data presented in **Table (2)** indicate that a significant increase of fresh and dry yield of whole plant leaves, stems, spikes and the net accumulated yield. This trend was observed at the second cut of the second season as increasing cutting height from 10 to 20 cm above the ground surface. While, a significant reduction in fresh and dry stems, whole plant and dry leaves were obtained at the first cut of both seasons. It could be concluded that increasing cutting height increased the productivity of reed canary grass under Mariout region for later cuts (**Tables 1 and 2**). These results are in harmony with those obtained by **El-Houssini (1999)** who pointed out that defoliating *Lolium multiflorum* to higher level was less productive at the first cut only.

4. Interaction effects

Data of the interactions between the main factors were divided into significant and insignificant effects. In this connection, the insignificant interactions were excluded and the significant interactions only will be discussed.

Interaction effect between organic manure and biofertilizer

Plant height seemed to be affected significantly by the above mentioned interaction at the three cuts taken at the first season (**Table 3**). The highest values of plant height were obtained when fertilized the soil by 20 m^3/fed. O.M. and inoculated grains with nitrogen fixing bacteria (NFB). This trend was obtained at the first two cuts, while at third cut, the greatest value was observed as inoculation with mixture of (NFB + PDB) with fertilizer 40 m^3/fed. O.M. The maximum number of leaves at second cut and the highest value of fresh leaves yield at third cut, were obtained by applying 40 m^3/fed sheep dung manure and inoculation grains with phosphate dissolving bacteria (PDB). Total fresh yield and stem fresh yield were significantly affected by that interaction in the first and third cuts of the second season. It was noticed that inoculation with mixture of (NFB and PDB) acted with 20 or 40 m^3/fed. O.M. gave the high positive response.

II. Microbiological analysis

Microbiological activities in the rhizosphere of canary grass plants have been periodically determined at three stages of growth during the first season 2003-2004.

Results of heterotrophic plate counts, i.e. the total microbial count, presented in **Table (4)** clearly show the highest density (222 X 10^6 cfu g^{-1} dry soil) was achieved when using a mixture of biofertilizers (NFB + PDB) and organic manure at a level of 20 m^3 fed^{-1} with cutting height of 10 cm at the second cutting. The role of biofertilization in increasing total soil microbial counts is obvious due to providing two main nutritive elements, i.e., nitrogen and phosphorus in available forms. Amending soil with organic fertilizer led to enhancement of microbial growth as a result of supplying microorganisms by carbon and energy sources needed for their growth and proliferation.

Counts of *Azotobacter* (**Table, 5**) reached their maximum level in plant rhizosphere by application of organic manure (20 m^3 fed^{-1}), multibiofertilizers (NFB + PDP), with cutting height of 10 cm at the second cutting time (354 X 10^4 cfu g^{-1} dry soil). This was followed by the treatment of adding NFB biofertilizer under the same mentioned conditions being 236 X 10^4 cfu g^{-1}. A marked increase of *Azotobacter* count was found to be complained by application of organic manure and phosphate dissolving bacteria. This observation is quite logic and expectable since *Azotobacter* bacteria need organic carbon and available phosphate to build up their cells and to synthesize a lot of ATP molecules required for atmospheric nitrogen fixation process.

With regard to counts of *Azospirillum* bacteria, results presented in **Table (6)** exhibited that *Azospirillum* behaved in the same manner as *Azotobacter* did. *Azospirillum* counts achieved the highest level (211 X 10^3 cells g^{-1} dry soil) in the presence of organic manure (20 m^3 fed^{-1}), application of the multibiofertilizer (PDB + NFB), cutting height (10 cm) at the second cutting time .

In concern with phosphate dissolving bacteria (PDB) results in **Table (7)** show that counts of phosphate bacteria gradually increased with plant growth to reach

Table 3. Effect of interaction between organic manure and biofertilizer on some vegetative and forage yield of reed canary grass in 2003/04 and 2004/05 growing seasons.

O.M m³/fed.	2003/2004								
	1st cut			2nd cut			3rd cut		
Biofertilizer	0	20	40	0	20	40	0	20	40
	Plant height			Plant height			Plant height		
Without	51.2	51.2	53.55	72.83	74.3	75.35	92.3	88.92	89.3
	bAB	bB	aAB	aA	aA	aA	aA	aAB	aB
PDB	53.2	56.17	56.23	69.13	75.98	78.62	89.47	82.07	92.3
	aA	aAB	aA	bA	aA	aA	aAB	bB	aA
NFB	53.53	58.17	52.43	75.81	79.03	73.07	87.45	92.92	91.66
	bA	aA	bAB	aA	aA	aA	bB	aA	aAB
(NFB+PDB)	49.23	56.23	47.7	71.67	75.58	70.18	93.87	85.5	95.45
	bB	aAB	bB	abA	aA	bB	aA	bB	aA
				Number of leaves/unit			Fresh leaves (T/fed.)		
Without	-	-	-	202.72	163.38	198.81	0.988	0.772	1.001
				aA	bB	abAB	aB	bB	aAB
PDB	-	-	-	172.85	208.6	216.74	1.003	0.685	1.800
				bAB	aA	aA	abA	bB	aA
NFB	-	-	-	207.81	193.3	176.35	1.004	0.978	0.749
				aA	abAB	bAB	aA	abAB	bB
(NFB+PDB)	-	-	-	153.91	184.23	155.292	0.894	1.022	0.929
				bB	aAB	bB	bB	aA	AB
	2004/2005								
	Total fresh yield (T/fed.)						Fresh stems (T/fed.)		
Without	7.06	7.66	4.25	-	-	-	1.973	1.381	2.079
	aA	aA	bB				abB	bB	aAB
PDB	5.97	6.84	6.89	-	-	-	2.178	1.499	1.477
	aB	aB	aA				aAB	bAB	bB
NFB	8.04	7.56	6.38	-	-	-	1.633	1.977	2.117
	aA	abA	bAB				bB	aA	aA
(NFB+PDB)	6.98	8.60	5.98	-	-	-	2.364	1.975	2.411
	abAB	aA	bB				aA	abA	aA

* Means having similar capital letters in same columns and small letters in same rows are not statistically different at 5% level of significance

Table 4. Effect of organic manuring, bioferetilization and cutting height at different cutting times on total microbial count (heterotrophic plate count) in rhizosphere of canary grass (count x 10^6 cfu g^{-1} dry soil).

Biofertilizers	Organic manure	0						20 m^3 fed^{-1}						40 m^3 fed^{-1}					
	Cutting height (cm)	10			20			10			20			10			20		
	Cutting time (growth stage)	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Without biofertilization		13	38	41	12	41	28	41	77	65	35	60	46	26	48	51	26	49	58
PDB		60	103	101	52	98	92	102	150	142	96	138	146	107	122	122	86	139	118
NFB		63	120	113	55	102	66	95	162	155	102	151	101	101	141	132	77	134	120
PDB + NFB		85	172	161	85	179	151	122	222	206	116	192	98	98	203	185	94	181	186

PDB : Phosphate dissolving bacteria. NFB : Nitrogen fixing bacteria (*Azotobacter* + *Azospirilum*).

Table 5. Effect of organic manuring, bioferetilization and cutting height at different cutting times on *Azotobacter* count in rhizosphere of canary grass (count x 10^4 cfu g^{-1} dry soil).

Bioferti-lizers	Organic manure	0						20 m^3 fed^{-1}						40 m^3 fed^{-1}					
	Cutting height (cm)	10			20			10			20			10			20		
	Cutting time (growth stage)	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Without biofertilization		9	21	21	11	16	18	18	40	33	16	30	23	12	22	20	13	23	25
PDB		26	56	50	30	45	41	61	130	109	60	121	96	44	81	85	41	77	70
NFB		80	171	141	77	115	98	132	236	205	140	210	188	112	198	207	109	200	183
PDB + NFB		96	190	170	92	147	132	175	354	311	170	302	293	146	302	300	135	281	291

PDB : Phosphate dissolving bacteria. NFB : Nitrogen fixing bacteria (*Azotobacter* + *Azospirilum*).

Table 6. Effect of organic manuring, bioferetilization and cutting height at different cutting times on *Azospirillum* count in rhizosphere of canary grass (count x 10^3 cfu g^{-1} dry soil).

Biofertilizers	Organic manure	0						20 m^3 fed-^{1}						40 m^3 fed-^{1}					
	Cutting height (cm)	10			20			10			20			10			20		
	Cutting time (growth stage)	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Without biofertilization		2	7	5	2	9	5	10	24	19	9	18	13	7	13	12	8	13	15
PDB		15	33	30	18	27	24	36	78	65	36	72	57	26	48	48	24	46	42
NFB		48	102	84	46	69	59	78	141	123	84	126	112	67	118	124	65	120	109
PDB + NFB		57	114	102	55	88	78	105	211	186	102	181	175	87	181	180	81	168	174

PDB : Phosphate dissolving bacteria. NFB : Nitrogen fixing bacteria (*Azotobacter* + *Azospirilum*).

Table 7. Effect of organic manuring, bioferetilization and cutting height at different cutting times on phosphate dissolving bacterial count in rhizosphere of canary grass (count x 10^3 cfu g^{-1} dry soil).

Biofertilizers	Organic manure	0						20 m^3 fed-^{1}						40 m^3 fed-^{1}					
	Cutting height (cm)	10			20			10			20			10			20		
	Cutting time (growth stage)	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Without biofertilization		4	10	11	5	11	11	12	26	29	10	22	32	9	19	19	11	21	26
PDB		31	61	69	36	50	50	71	140	151	72	151	171	59	101	116	45	92	99
NFB		7	15	16	9	12	16	20	33	39	18	40	63	16	26	33	13	25	32
PDB + NFB		30	67	73	42	50	48	78	144	152	80	162	181	62	92	96	55	103	129

PDB : Phosphate dissolving bacteria. NFB : Nitrogen fixing bacteria (*Azotobacter* + *Azospirilum*) their maximum at the third cut. Application of biofertilizers either PDB alone or PDB together with NFB led to an increase in phosphate dissolving bacterial counts.

Summing up, it could be concluded that application of multibiofertilizer containing phosphate dissolving bacteria (PDB) and nitrogen fixing bacteria (NFB) in presence of organic manure, markedly activated soil microorganisms in the plant rhizospheric region. These findings are in agreement with those previously reported by **Eid *et al* (1984); Zambre *et al* (1984) El-Borollosy *et al* (1986); Ishac *et al* (1986) and Mashhoor *et al*** (2000) who stated that inoculation of cereal plants with associative nitrogen fixing bacteria and (or) phosphate dissolving bacteria greatly stimulated rhizosphere micoorganisms and allowed regular release of available nitrogen and phosphate sources for plant growth.

REFERENCES

Abdel-Azeem, Hoda H. (1998). ***Production of a Biofertilizer Convenient for Desert Soil to Limit the Environmental Pollution Resulted from Inorganic Manuring. pp. 111-115.*** Ph.D. Thesis, Institute of Environmental Studies and Research, Ain Shams Univ. Cairo.

Abdel-Azeem, Hoda H. and Salwa A. El-Toukhy (2000). Response of Ryegrass (*Lolium multiflorum*) to biofertilization technology. ***8th Conf. Agric. Dev., Fac. Agric., Ain Shams Univ., Cairo, November 20-22, 2000 Annals Agric. Sci. Sp. Issue 2, 517-638.***

Abdel-Maksoud, H.K.; M.A. Khalafallah and M.S.M. Saber (1982). Effect of certain micronutrients on the activity of phosphate dissolving bacteria in calcareous soil cultivated with faba bean. ***Zbl. Mikrobiol., 13: 257-261.***

Abdel-Malek, Y. and Y.Z., Ishac (1968). Evaluation of methods used in counting *Azotobacter*. ***J. Appl. Bacterial, 31: 267-275.***

Boutroes, B.N.; M.A. Azazy and M.S.M. Saber (1987). The combined effect of soil conditioners and biofertilizers on growth and nutrient uptake by citrus seedling at nursery stage. ***Egypt. J. Soil Sci. 27 (3): 349.***

Devlin, R.M. (1984). ***Plant Physiology. Hand Book, p. 277.*** Van Nostrand and Reinhold Comp., New York,

Dobereiner, J. (1978). Influence of environmental factors on the occurrence of *Spirilum lipoferum* in soil and roots. ***Ecol. Bull. (Stokholm) 26: 343-352.***

Duncan, D.B. (1955). Multiple Range and Multiple (F.) test, ***Biometrics, 11:1-42.***

Eid, A.M.; N.A. Hegazi; M. Monib and E. Shokr (1984). Inoculation of grain sorghum with azospirilla. ***Rev. Ecol. Biol. Sot.21 (2): 235-242.***

El-Borollosy, M.A.; Y.Z. Ishac; M.E. El-Haddad and M.E. El-Demerdash (1986). Response of maize plants to inoculation with asymbiotic N2-fixers. ***Proc. 2nd AABNF Conf.Cairo, Egypt. pp. 538-539.***

El-Houssini, A.A. (1999). Forage production of Italian Ryegrass (*Lolium multiflorum* Lam.) as affected by seeding rate, nitrogen fertilizer and cutting height under calcareous soil conditions. ***Annals of Agric. Sci. Moshtohor, 37(2):793-804.***

El-Toukhy, Salwa, A. (1997). ***Management System of New Improved Range Areas of North Western Coast to Control Desertification. pp. 59-77.*** Ph.D. Thesis. Institute of Environmental Studies and Research, Ain Shams Univ. Cairo.

El-Toukhy, Salwa, A. and Hoda A. Abdel-Azeem (2000). Response of Barley (*Hordium vulgare*) to Biofertilization Technology, *8th Conf. Agric. Dev. Res., Fac. Agric., Ain Shams Univ., Cairo, Novembver 20-22, 2000. Annals Agric. Sci., Sp. Issue 2: 539-559.*

Essa, T.A. and B.A. Rawi (2003). Effect of dipping treatment on forage and grain yield of barley genotypes. *Annals Agric. Sci. Ain Shams Univ., Cairo 48 (1): 185-196.*

Gaber, U. (2002). Cutting frequency and stubble height of reed canary grass (*Phalaris arundinacea* L.). Influence on Quality and Quantity of biomass for biogas production. *Grass & Forage Science. Vol. 57: p. 389.*

Hernandoz, M.; M. Peraie and I. Tang (1994). Use of microorganisms as biofertilizers in tropical crops. *Pastos, J. Forrajes, 17(3): 183-192* (c.f. Computer Res.).

Ishac, Y.Z.; M.E. El-Haddad; M.E. Demerdash (1986). Effect of Seed bacterization and phosphate supplementation on wheat yield and mycorrhizal development. *Proc. 2nd AABNF Conf. Cairo, Egypt, pp. 597-710.*

Jackson, M.L. (1958). *Soil Chemical Analysis. pp. 219-221.* Prentic-Hall, Inc. England, cliffs.

Mashhoor, W.A.; Sohair A. Nasr; Mervat A. Amara and Karima, K. Mikhail (2000). Tolerance of *Azotobacter* strains to adverse environmental conditions. *Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, 8 (1): 79-97.*

Mowafy, S.A.E. (2002). Effect of organic manuring and splitting of different levels of nitrogen on wheat under sprinkler irrigation in sandy soils. *Zagazig J. Agric. Res., 29 (1): 51-72.*

Page, A.L.; R.H. Miller and D.R. Keeney (1982). *Methods of Soil Analysis. Part 2, pp. 781-802,* Chemical and microbiological properties. Madison, Wisconson, USA.

Patel, R.H.; T.G. Meisheri and J.R. Patel (1996). Analysis of growth and productivity of Indian mustard (*Brassica juncea*) in relation to FYM, nitrogen and source of fertilizer. *J. Agronomy Crop Science 177: 1-8.*

Rizk, T.Y.; Zeinab M. Nassar, H.A. El-Kassas and N.H. Baumi (2000). Growth and forage production of *Phalaris canariensis* L. as affected by nitrogen and natural fertilization resources. *J. Agric. Sci., Mansoura Univ., Egypt, 25(7): 3813-3829.*

Snedecor, G.W. and W.G. Cochran (1980). *Statistical Methods 7th (Ed.)* Iowa State Univ. Press. Ames Iowa, U.S.A.

Studdy, C.D.; R.M. Moris and I. Ridge (1995). The effect of separated cow slurry liq uor on soil and herbage nitrogen in *Phalaris arundinaceae* and *Lolium perenne. Grass and Forage Sci., 50: 106-111.*

Taha, S.M.; S.A. Mahmoud, A.H. El-Damaty and A.M. Abdel Hafez (1969). Activity of phosphate dissolving bacteria in Egyptian Soil. *Plant and Soil, 3: 142-148.*

Tripathi, A.K.; B.M. Mishira and P. Tripathi (1998). Salinity stress response in the plant growth promoting rhizobacteria, *Azospirillum* spp. *J. Biosc. 23: 463-471.*

Zambre, M.A.; B.K.Konde and K.R.Sonar (1984). Effect of *Azotobacter chroococcum* and *Azospirillum brasilense* inoculation under graded levels of nitrogen on growth and yield of wheat plant. *Plant and Soil, 79(1):61-67.*

المؤتمر العاشر لبحوث التنمية الزراعية، كلية الزراعة، جامعة عين شمس، القاهرة، مصر، ٢٠٠٦
مجلد خاص، حوليات العلوم الزراعية، عدد خاص، ١، ٦٥-٨٣، ٢٠٠٦

النمو والمحصول العلفي لنبات الفلارس المتأثر بالسماد العضوى والحيوى وارتفاعات الحش تحت ظروف الأراضى الجيرية

[٦]

سلوى على الطوخي[١]- هدى حسن عبد العظيم[٢]
١. وحدة المراعي- مركز بحوث الصحراء- المطرية- القاهرة- مصر
٢. وحدة ميكروبيولوجيا الأراضي- مركز بحوث الصحراء- المطرية- القاهرة- مصر

تم تنفيذ تجربتان حقليتان بمحطة بحوث مريوط - مركز بحوث الصحراء خلال موسمى ٢٠٠٣/٢٠٠٤ و٢٠٠٤/٢٠٠٥ وذلك لدراسة تأثير الحش على ارتفاعين مختلفين (١٠ ، ٢٠ سم) من سطح الأرض وثلاثة مستويات من التسميد العضوى (مخلفات الأغنام) ، (صفر - ٢٠ - ٤٠م^3/فدان) وأربعة أنواع من التسميد الحيوى (بدون تلقيح - البكتريا المذيبة للفوسفات - مخلوط الأزوتوباكتر والأزوبيريلم المثبت للنيتروجين - المخلوط السابق مضافا إليه البكتريا المذيبة للفوسفات)وذلك على نمو ومحصول الفلارس وكذلك على النشاط الميكروبى بمنطقة الجذور - وقد استخدم تصميم القطاعات المنشقة مرتين فى أربعة مكررات، وقد شغلت ارتفاعات الحش القطع الرئيسية - التسميد العضوى - القطع المنشقة بينما وزعت معاملات التسميد الحيوى فى القطع تحت المنشقة- وقد كان النبات المستخدم هو نبات حشيشة الكنارى (الفلارس).

وتتلخص أهم النتائج فى الآتى

١- أدى استخدام ارتفاعات مختلفة للحش الى التأثير المعنوى على صفات النمو المختلفة - وقد أدى ارتفاع الحش الى ٢٠ سم الى نقص معنوى لكل من المحصول الغض والجاف للنبات الكامل وأجزائه والأوراق والسيقان فى الحشة الأولى لكلا الموسمين - فى حين أدى هذا الارتفاع الى زيادة المحصول الغض والجاف للسيقان والأوراق والسنابل وكذلك المحصول المتجمع الكلى للموسم والى زيادة معنوية فى الحشة الثانية للموسم الثانى.

٢- أدى استخدام مخلفات الأغنام الى تحسين جميع صفات النمو للفلارس وانعكس ذلك على المحصول الغض والجاف للنبات.

٣- أدى استخدام التسميد الحيوى إلى زيادة معظم صفات النمو وتحسـينه وكـذلك المحصول الغض والجاف تحت ظروف الأراضى الجيرية لمنطقة مريوط.

٤- أوضحت نتائج التحليل الميكروبيولوجى لعينات التربة من المعاملات المختلفة أن استخدام مخلوط من السـماد الحيـوى المكون من بكتريا مثبتـة للنيتـروجين، بالإضافة الى بكتريا مذيبة للفوسفات فى وجود السماد العضوى أدى الى أعلـى مستوى للنشاط الميكروبى فـى منطقـة الريزوسفير تمثـل فـى زيـادة كثافـة الميكروبات الكلية وبكتريا الأزوتوباكتر والأزوسـبيريللم ومـذيبات الفوسـفات الكلية، الأمر الذى يلعب دوراً أساسياً فى توفير العناصر الغذائية للنبات بصـورة ميسـرة تحـت ظـروف الأراضـى الجيريـة.

تحكيم: ا.د وجدى عبد المنعم مشهـــور
ا.د عبد المنعم محمد أحمد حجازي