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EFFECT OF ORGANIC BIOGAS MANURE AND MACRO-ELEMENTS FERTILIZER (NPK) ON FODDER PEARL MILLET (*PENNISETUM GLAUCUM*, L.) YIELD AND ITS NUTRITIVE VALUE IN SOUTH SINAI

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Two field experiments were conducted at Ras-Sudr Research Station, South Sinai Governorate during summer (2001 and 2002) seasons. Twelve treatments were done as the combination of four rates from biogas manure; without manure (control), 2, 4 and 6 ton/fed. and three macro elements fertilizer NPK (20:12:4, 24:16:8 and 28:20:12 kg of N, P_2O_5 and K_2O per fed., respectively) on fodder pearl millet *(Pennisetum glaucum* L.*)* cv. Shandawel 1, with four replicates. That is to study the effect of organic biogas manure and macro elements fertilizer (NPK) on cutting yield and its nutritive value.

Increasing biogas manure rates from2 ton /fed. up to 6 tons / fed. or macro- elements from NPK1 to NPK2 increased significantly fodder green and dry yields of two cuttings in both seasons. Green and dry yield of treatment (6 tons/ fed. biogas manure + NPK1) were superior compared with other treatments.

In both seasons, increasing biogas manure from 2 to 6 tons /fed. or macro- elements fertilizer from NPK1 to NPK3 increased percentages of nitrogen, crude protein, phosphorus and crude fiber and decreased percentages of silica in the two cuttings. Concerning the significant interaction between the two factors (6 tons /fed. biogas + NPK3) gave the highest value of all chemical nitrogen, crude protein, phosphorus and crude fiber except percentages of silica in both seasons.

Overall, the results have revealed that the yield and quality of forage from the fodder crop of pearl millet increased and improved in the treatments that received rate of the biogas manure at 6 tons / fed. plus NPK1 than in the NPK1 treatment alone.

Keywords: Pearl millet *(Pennisetum glaucum* L.*)*, fodder crop, biogas, macro- elements, NPK fertilizer, cutted yield, South Sinai

Pearl millet *(Pennisetum glaucum* L.) produces high yield of palatable quality green fodder crop in summer which is not sufficient to meet animal needs after the end of the winter season, especially with the recently extensive increases in the animal production. It is necessary to increase forage yield per feddan by improving agricultural practices during the growing season, where there is a great shortage in the animal feed stuff (Mousa, 1991). It is heat tolerant, efficient in the utilization of moisture and has higher value than sorghum or maize, it has higher fodder yield because of its large stems, leaves, and heads and it has very low hydrocyanine acid content (Khairwal, 1990).

Saline soil in arid and semi - arid areas, located in the Eastern Mediterranean zone pose difficulties in land use since the application of ameliorative measures is very much constrained by economic and climatic factors. Salinity, reducing the growth and productivity of crops, has created enormous problems for agriculture in many parts of Egypt. Generally under salt stress, plant growth is reduced as evident by Clipson *et al.* (1985), Abd El Rahim *et al.* (1990) and Ibrahim *et al.* (1991).

Fermentation of organic residues under an aerobic condition can provide farmers with native sources of energy, namely (biogas manure), the digested materials are considered as a good source of organic manure rich in water, soluble major and minor plant nutrients and some growth regulating substances. The digested biogas manure generated daily after an aerobic fermentation of organic residues, i.e., cow and sheep dung ... etc., is considered as a good source of nutrients for plants and an excellent soil conditioner. Also, biogas manure is poor in weed seeds as a result of its fermentation under an aerobic condition (FAO, 1978)

Organic fertilizer plays role in plant nutrition as well as in soil conservation. It improves the physical condition of the soil by improving texture, moisture holding capacity and aeration (Maramba *et al.* 1978).

Fertilizer application to Pearl millet is often very small or not done at all (Ahmed *et al.* 1982; Singh and Ahmed, 1983). There is a strong need to adopt integrated nutrient supply system by judicious combination of bio-and chemical- fertilizers to improve soil health, crop productivity, save money and conserve environment (Verma and Bhattacharyya,1990).

Therefore, the present research aimed to study the effect of four levels of biogas manure and three levels of macro elements fertilizer (NPK) on two cuttings (The first cut after 60 days from sowing and the second cut after 60 days from the first cut) under saline stress conditions.

MATERIALS AND METHODS

Two field experiments were conducted at Ras-Sudr Agricultural Experimental Station, South Sinai Governorate during 2001 and 2002 summer seasons to study the effect of four levels of biogas manure and three levels of macro elements fertilizer (NPK) on pearl millet *(Pennisetum glaucum* L.) cv., Shandawel 1.

Twelve treatments were the combinations between biogas manure rates (without manure, control, 2, 4, and 6 ton /fed.) and three NPK compounds of N: P_2O_5 and K_2O, kg NPK / fed. (20: 12: 4, 24: 16: 8 and 28: 20: 12, respectively). Split plot design was done with four replicates, plot area was 2 m x 3 m size ($6m^2$) containing 4 ridge; each ridge was three meter length and 50 cm width. The main plot consisted of the three compounds of NPK while sub plot were arranged for biogas manure. The biogas manure was supplied from the Biogas Training Center at Moshtohor, Kalyubia Governorate.

Organic biogas manure rates were mixed with upper surface soil of each plot and applied basally before sowing. NPK kg/fed. compound levels were applied uniformly of soil plot in all treatments basally before sowing. Irrigation water salinity from sowing tile harvest from the well salinity reached 4249 ppm in the first season and 4442 ppm in the second season. Physical and chemical analyses of experimental soil are presented in tables (1a and 1b).

TABLE (1a). Physical analysis of Ras-Sudr soil in 2001 and 2002 seasons

Characters / Seasons	Sand %	Silt %	Clay %	Soil Texture
2001	78.1	16.7	5.2	Sandy loam
2002	76.9	19.4	3.7	Sandy loam

TABLE (1b). Chemical analysis of Ras-Sudr soil in 2001 and 2002 seasons

Characters / Seasons	pH	EC dS/m	Soluble Cations (meq / l)				Soluble Anions (meq / l)			
			Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^-	HCO_3^-	Cl^-	SO_4^-
2001	7.98	6.64	15.62	0.99	15.62	9.91	-	2.4	26.50	13.24
2002	8.09	6.94	35.53	3.21	19.33	14.87	-	3.6	44.60	24.74

Data in table (2) showed the chemical analysis of biogas manure. Grains were sown on May 1st in 2001 and May 4th in 2002 seasons. The normal agricultural treatments of growing pearl millet plants were practiced. The forage crop was cut on 60 days from sowing and the green fodder yields were recorded. Green fodder samples were drawn to determine plant height (cm), fresh weight (g/plant), dry weight (g/plant), fresh and dry weights at the first and second cuts in both seasons (The first cut after 60 days from sowing and the second cut after 60 days from the first cut). Chemical samples were drawn from two cuttings in both seasons and were analysed for nitrogen, protein (N X 6.25), silica, phosphorus, and crude fiber according to A.O.A.C. (1970).

TABLE (2). Chemical analysis of biogas manure in 2001 and 2002 season

Biogas manure	O.C %	O.M %	T.N %	Available K %	T.K %	Available P %	T. P %	C:N ratio	Soluble NH_4^+N ppm	$N\text{-}NO_3^-$ ppm
2001	40.07	69.10	1.580	1.589	1.742	0.402	0.651	32.1	40	27
2002	24.36	41.99	1.370	2.10	1.502	0.16	0.542	18.1	26	14

O.C = Organic Carbon, O.M = Organic Matter, T.N = Total Nitrogen, T.K = Total Potassium, T.P = Total Phosphorus, C: N = Carbon: Nitrogen ratio.

The data were analyzed statistically as a split plot design. Analysis of variance for the data was used according to Snedecor and Cochran (1984). Main comparison was done using LSD at 5%.

RESULTS AND DISCUSSION

A- On the First Cut (60 Days from Sowing)

1-Effect of organic biogas manure

Data in fig (1) showed increasing organic biogas manure rate from 2 tons /fed. to 6 tons / fed. increased significantly plant height, fresh and dry weight per plant in both seasons. Sathianathan (1975) found that the role of manures in sustaining soil fertility has been well established long time ago. Manures differ in their efficiency as fertilizers according to their origin and processing techniques as it obtained from biogas plants are known to be rich in both macro- and micro-nutrients. These results agreed with many researchers (Ojha and Baroova, 1997; Brar *et al.*, 1999). These may be due to organic fertilizer as biogas manure plays an important role in plant nutrition and soil conservation as well. It is also an excellent soil conditioner. It improves the physical condition of the soil. Moreover, biogas treatments are poor in weed seeds as a result of its fermentation under an-aerobic condition (Maramba *et al.*, 1978).

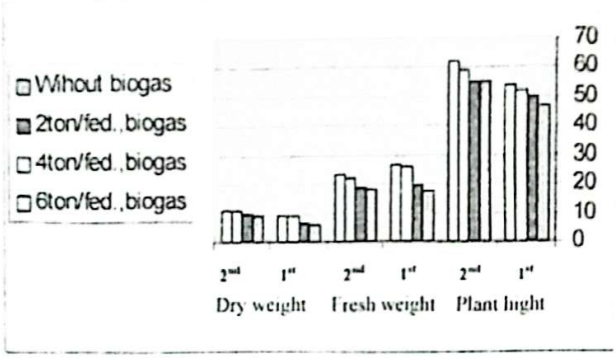


Fig (1). Effect of biogas manure on some plant characters after 60 days from sowing in 2001 (1st) and 2002 (2nd) seasons.

2- Effect of macro elements (NPK) fertilizers

Data in fig (2) showed increasing NPK fertilizers from NPK1 to NPK2 increased significantly plant height, fresh and dry weight per plant in the first season but in the second season plant height was insignificant. This may be due to the increases of fresh forage yield of plants fertilized with NPK as a result of the increase in the quantity of fertilizers added to the soil that might favour a proper balance between nutrient elements in the root media. These results agreed with Pieterse *et al.* (1992). Moreover, increasing NPK2 to NPK3 decreased significantly plant height, fresh and dry weights per plant in both seasons. Increasing NPK elements fertilizer from NPK2 to NPK3 increased total electrolyte concentration within plant root zone which has a general deleterious effect on plant growth which is manifested as nearly equivalent reduction in the transpiration and growth rates (Rhoades *et al.* 1992).

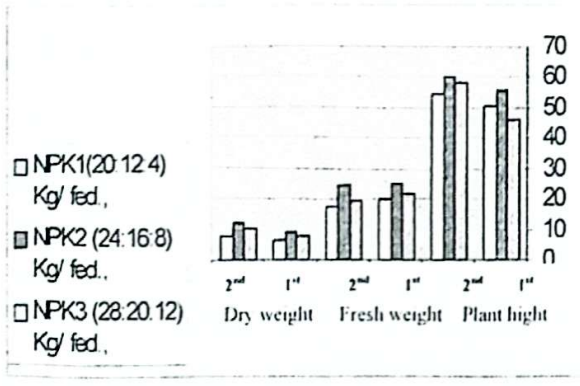


Fig (2). Effect of macro- elements fertilizer NPK after 60 days from sowing in 2001 (1st) and 2002 (2nd) seasons.

3-Effect of the interaction between organic biogas manure and macro elements fertilizer (NPK)

Data in fig (3) showed the effect of the interaction between organic biogas manure and macro-elements fertilizer (NPK) on some characters of pearl millet plant after 60 days from sowing. Plant heights, fresh and dry weight per plant were significantly higher in summer seasons of 2001 and 2002 with the application of 6 tons /fed. organic biogas manure plus first dose of NPK1 compared with the other treatments. Application of macro-element fertilizers NPK1 and biogas manure in combination of the first dose ($20N:12P_2O_5$: 4 K_2O) kg/ fed. and 6 tons /fed. biogas manure significantly increase plant height, fresh and dry weight /plant. In general, it justifies that incorporation of the biogas manure with macro nutrient fertilizers NPK1 is more effective than received fertilizer schedule alone. This may be due to the positive effects of biogas manure on the crop growth through supply of all nutrients and growth principles and through the improvement in the general soil health.These results were confirmed with Hooda *et al.(*1991),Vasanthi *et al.* (1998) and Desale *et al. (*2000) who found that the application of 75 % of the recommended NPK (60:30:30kg /h) to pearl millet + 10 ton farmyard manure gave the highest significant green forage and dry matter, due to the ability of plant to grow in marginal soil. There is a need to develop a system using organic manure and inorganic fertilizers in a complementary way. These may enhance the efficiency and reduce the requirement of inorganic fertilizers.

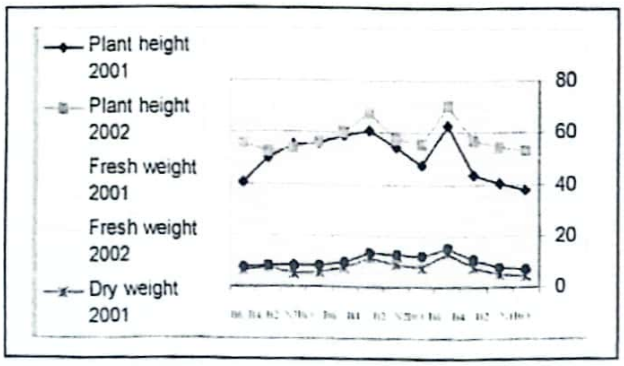


Fig (3). Effect of the interaction between biogas manure and NPK fertilizers after 60 days from sowing on some plant characters in 2001 and 2002 seasons.

B- Two Cuttings Fodder Yield of Pearl Millet

1-Effect of organic biogas manure

Data in figs (4a and 4b) indicated that increasing biogas manure rates from 2 tons / fed. up to 6 tons / fed. increased significantly fodder green and dry weight yield, in the first and second cuts, in both seasons. This may be due to that biogas manure (fermentation of organic residues under an-aerobic conditions) is considered as an inoculation of the soil with several types of

micro-organisms which help in the essential chemical processes in the soil leading to furnish available plant nutrients (Thompson and Troeh, 1980). The role of manures in sustaining soil fertility has been well established long time ago. Manure differ in their efficiency as fertilizers according to their origin and processing techniques as it obtained from biogas plants are known to be rich in both macro- and micro- nutrients (Sathianathan, 1975). These results agreed with many researchers (Mahmoud *et al.*, 1982; Mourad *et al.*, 1986 and El-Shimi *et al.*, 1987) who found that plant height was enhanced significantly by biogas treatments up to 90 kg effluent N /fed.

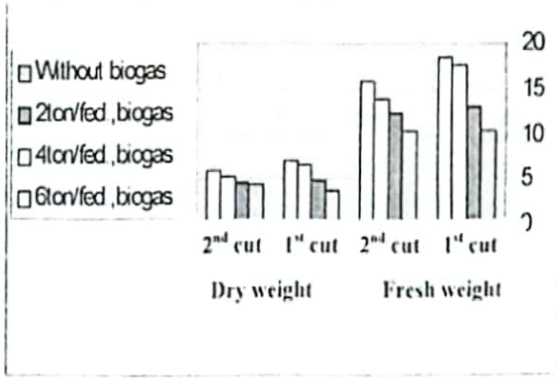


Fig (4a). Effect of biogas manure on fodder yield of the first and second cuts (ton/fed.) in 2001 season.

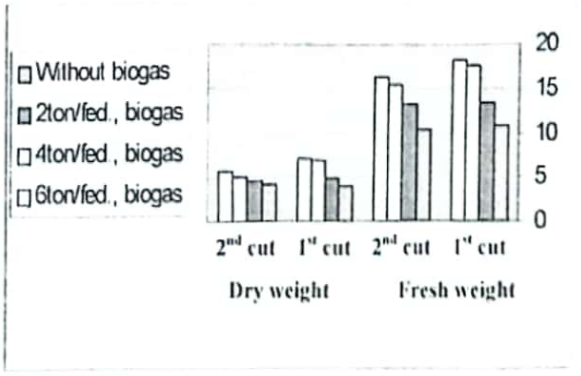
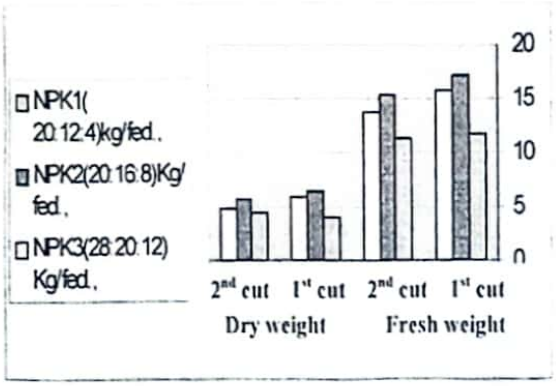


Fig (4b). Effect of biogas manure on fodder yield of the first and second cuts (ton/fed.) in 2002 season.

2-Effect of macro elements (NPK) fertilizer

Data in figs (5a and 5b) showed increasing macro-elements fertilizers from NPK1 to NPK2 increased significantly green and dry fodder yield (ton /fed.) in the first and second cuts in both seasons. Increasing fresh forage yield of plants fertilized with NPK might be attributed to the increase in the

quantity of fertilizers added to the soil that might favour a proper balance between nutrient elements in the root media. These results were confirmed by Pieterse *et al.* (1992). Whereas increasing NPK2 to NPK3 deacreased significantly green and dry fodder yield in both seasons, except fresh fodder weight of the second cut. These results agreed with Coaldrake and Pearson(1985), Ong and Monteith (1985), Kramalinga and Cbajaj (1989), El-Kased (1993) and Vasanthi *et al.* (1998) they found that the plant height and dry weight /plant of pearl millet increased significantly with the application of P and K. For each regrowth rate decreased latter cuts. In 2001 season, the green fodder yields of the first and second cuts for treatments fertilized by NPK2 were 17.22 tons /fed. and 15.44 ton /fed. respectively. These results agreed with Tikhomirova (1985) and Ramasamy *et al.* (1993).



Fig(5 a). Effect of macro- elements fertilizers (NPK) on fodder yield of the first and second cuts (ton/fed.) in 2001 season.

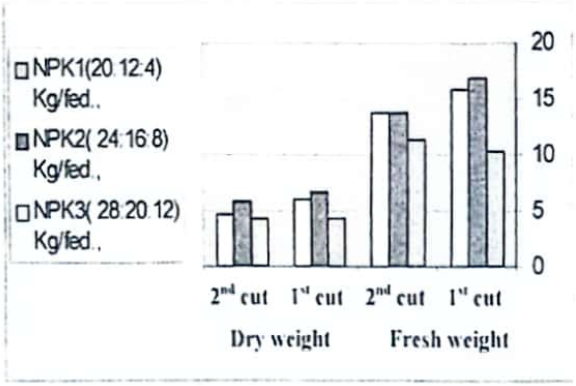


Fig (5 b). Effect of macro- elements fertilizer (NPK) on fodder yield of the first and second cuts (ton/fed.) in 2002 season.

3-The interaction between organic biogas manure and combined application with macro-element fertilizers (NPK)

Data in figs (6a and 6b) showed the effect of the interaction between organic biogas manure and combined application with macro-element fertilizers (NPK) on green and dry fodder yield of pearl millet at the first and

second cuts. The results further showed that the green and dry fodder yields in the treatment (biogas manure at 6 tons / fed. plus first dose of NPK (20:12:4) kg/fed.) were superior to other treatments. The highest level of biogas manure to the other levels showed that there was a possibility to save fertilizer rates of NPK alone. This may be attributed to the higher composition of macro-and micro-nutrients in the biogas manure. Similar results were reported by Chandrasekar *et al.* (1991) and Kailush *et al.* (1992). These results were confirmed by Vasanthi *et al.*(1998) who found that the green fodder yield of sorghum and pearl millet in the treatment that increased poultry manure at 10 tons/ ha plus 50% of the recommended NPK (60:40:20 kg of N, P_2O_5, K_2O/ ha) than the yield received fertilizer schedule alone. Desale *et al.* (2000) showed that the application of 75% of the recommended NPK (60:30:30 kg NPK/ ha) + 10 tons farmyard manure /ha to pearl millet gave the highest significant green forage and dry weight.

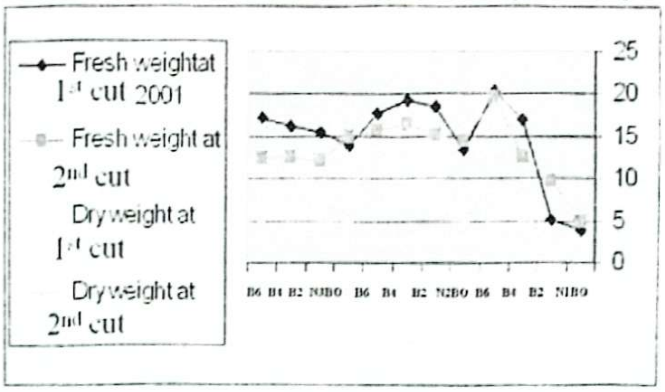


Fig (6a). Effect of the interaction between biogas manure and NPK fertilizer of the first and second cuts on fodder yield (ton/fed.) in 2001 season.

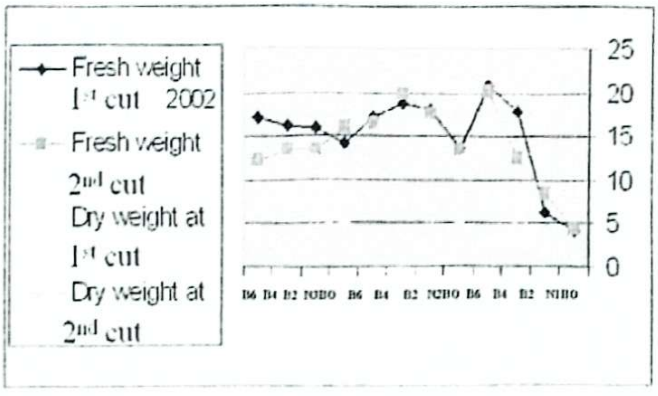


Fig (6b). Effect of the interaction between biogas manure and NPK fertilizer of the first and second cuts on fodder yield (ton/fed.) in 2002 season.

C- Quality Parameters

1-Effect of organic biogas manure

Data in figs (7a, b and c) showed the effect of organic biogas manure on nitrogen, protein, silica, phosphorus and crude fiber in the two cuttings in both seasons. Increasing organic biogas manure from 2 up to 6 tons /fed. increased significantly all chemicals nitrogen, protein, silica, phosphorus and crude fiber in both seasons, except percentages of silica was decreased and it was insignificant after 60 days from the first cut in first season. These results agreed with Hornick *et al.* (1979), Mahmoud *et al.* (1982), Vasanthi *et al.* (1998) and Desale *et al.* (2000). They found that application of biogas manure increased the content of mineral and protein in maize, sorgum and pearl millet plants, and the effluent manure supplies N,P,and K as well as considerable levels of micro-elements in a suitable form for plants.

It could be concluded that the application of biogas sludge could have several effects on soil, it may increase the organic matter content, the available macro- and micro-nutrients in the soil; it reduce the loss of mineral by leaching and concentrate nutrients likely to be deficient in the surface soil and keeping them in a readily available form (Mahmoud *et al.* 1984).

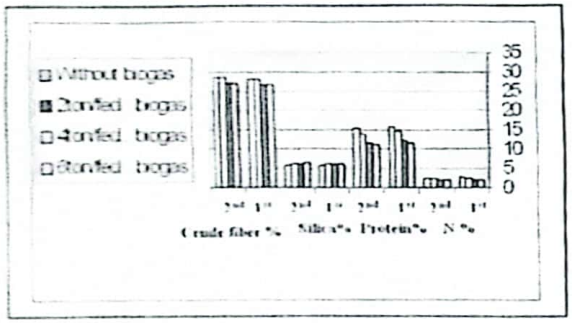


Fig (7a). Effect of biogas manure on the percentage of N, protein, silica and crude fiber of the first and second cuts in 2001 season.

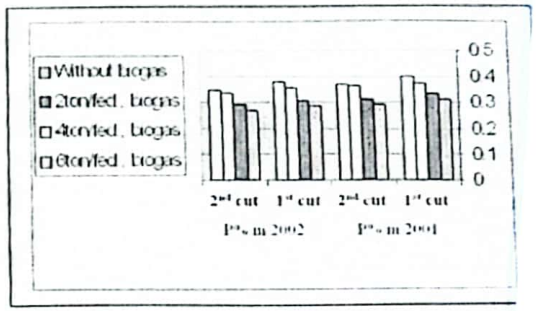


Fig (7b). Effect of biogas manure on P % of the first and s 2001 and 2002 seasons.

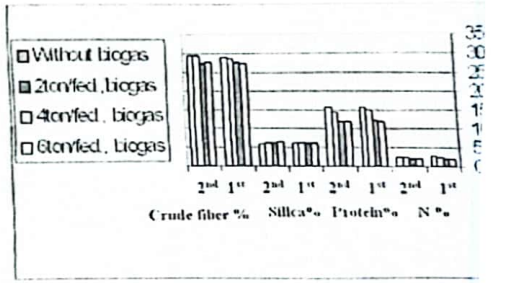


Fig (7c). Effect of biogas manure on the percentage of and crude fiber of the first and second cuts in

2-Effect of macro elements (NPK)

Data in figs (8a, b and c) showed increasing N increased significantly all chemicals nitrogen, protein, sili crude fiber in both seasons except percentages of silic both seasons and was insignificant after 60 days from the season. The increase in crude protein yield is probably d crude protein percentage as a result of increasing n These results are confirmed by Kumar *et al.* (1997) wh content of both cuttings (after 60 and 105 days) o *glaucum* L.) increased significantly with increasing leve with nitrogen.

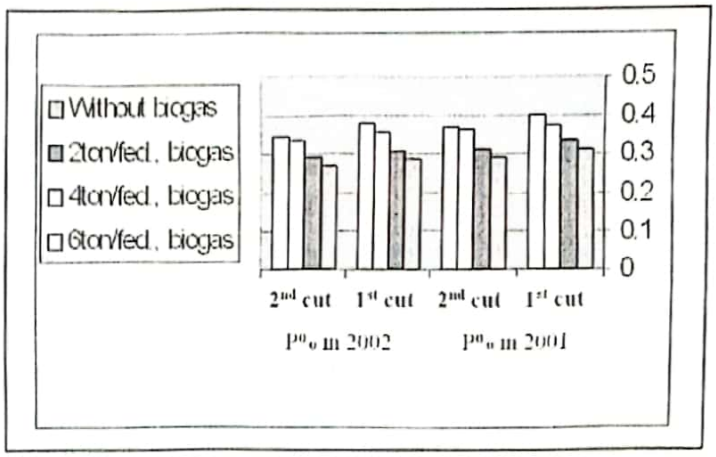


Fig (7b). Effect of biogas manure on P % of the first and second cuts in 2001 and 2002 seasons.

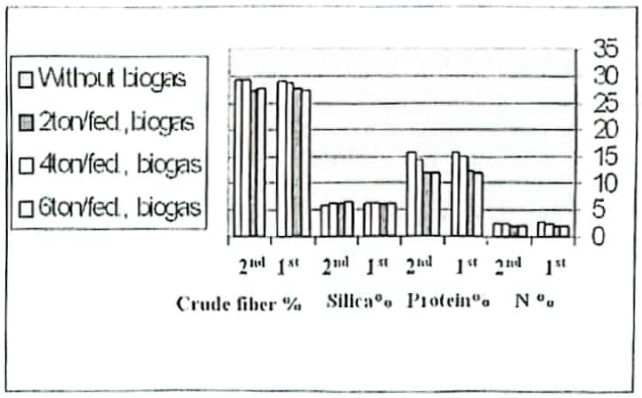


Fig (7c). Effect of biogas manure on the percentage of N, protein, silica and crude fiber of the first and second cuts in 2002 season.

2-Effect of macro elements (NPK)

Data in figs (8a, b and c) showed increasing NPK1 up to NPK3 increased significantly all chemicals nitrogen, protein, silica, phosphorus and crude fiber in both seasons except percentages of silica was decreased in both seasons and was insignificant after 60 days from the first cut in the first season. The increase in crude protein yield is probably due to the increase in crude protein percentage as a result of increasing nitrogen fertilization. These results are confirmed by Kumar *et al.* (1997) who found that protein content of both cuttings (after 60 and 105 days) of bajra (*Pennisetum glaucum* L.) increased significantly with increasing level of EC and fertilizer with nitrogen.

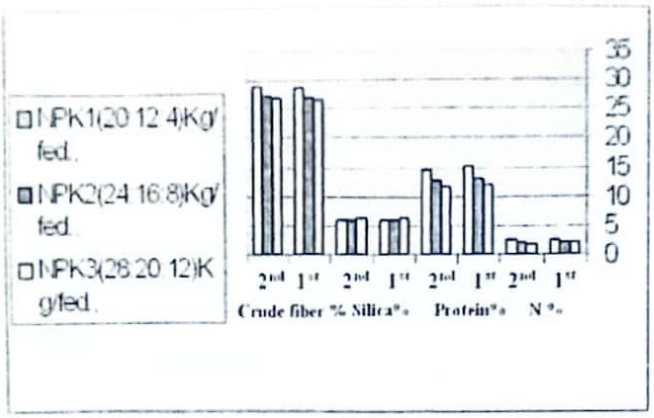


Fig (8a). Effect of macro- elements (NPK) fertilizer on the percentage of N, protein, silica and crude fiber of the first and second cuts in 2001 season.

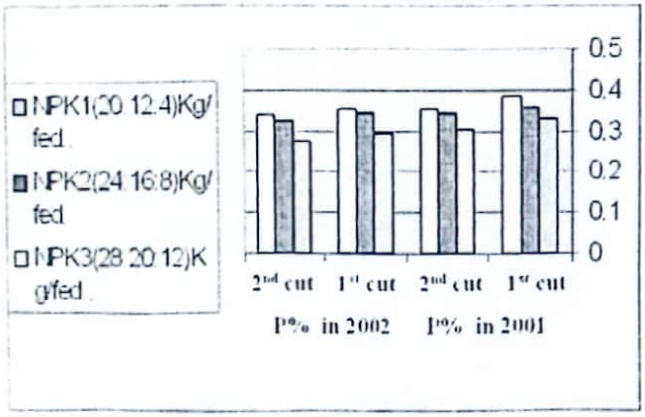


Fig (8b). Effect of macro- nutrient (NPK) fertilizer on P % of the first and second cuts in 2001and 2002 seasons.

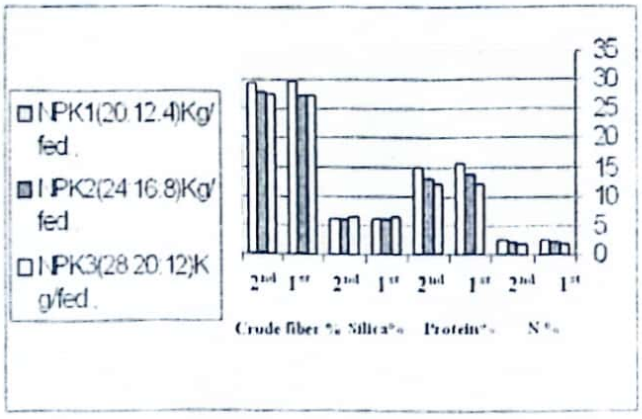


Fig (8c). Effect of macro- elements (NPK) fertilizer on the percentage of N, protein, silica, and crude fiber of the first and second cuts in 2002 season.

3-The interaction between organic biogas manure and macro elements (NPK) fertilizer

Data in figs (9a, b and c) showed chemicals nitrogen, protein, silica, phosphorus silica and crude fiber in the treatments that received biogas manure at 6 tons / fed. plus NPK3 (28:20:12 kg/ fed.) was higher significantly than other treatments, in both seasons except percentages of silica was decreased . These may be due to enhanced synthesis of crude protein facilitated by the supply of growth principles like enzymes from the manures. Similar results were reported by Vesanthi and Venkatakrishnan (1992).

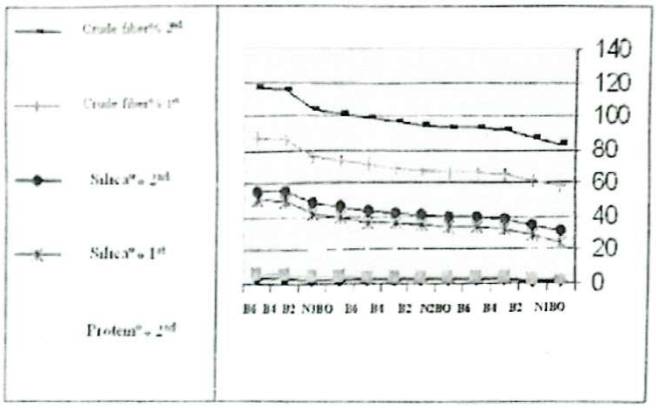


Fig (9a). Effect of the interaction between biogas manure and macro-elements (NPK) fertilizers on the percentage of N, protein, silica and crude fiber at the first and second cuts in 2001 season.

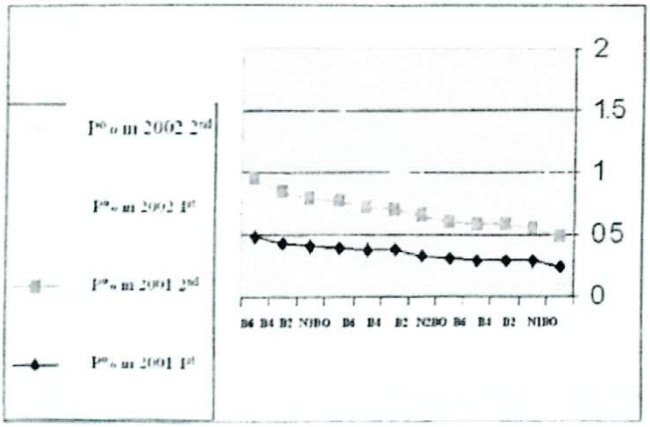


Fig (9b). Effect of the interaction between biogas manure and macro-elements (NPK) fertilizers on P% at the first and second cuts in 2001 and 2002 seasons.

However, silica content had significant reduction, this may be attributed to the increase in the proportion of soluble cellular content such as carbohydrates, proteins and fats.

Overall, the results have revealed that the yield and quality of forage from the fodder crop of pearl millet increased and improved in the treatments that received rate of the biogas manure at 6 tons / fed., plus NPK1 than in the NPK1 treatment alone.

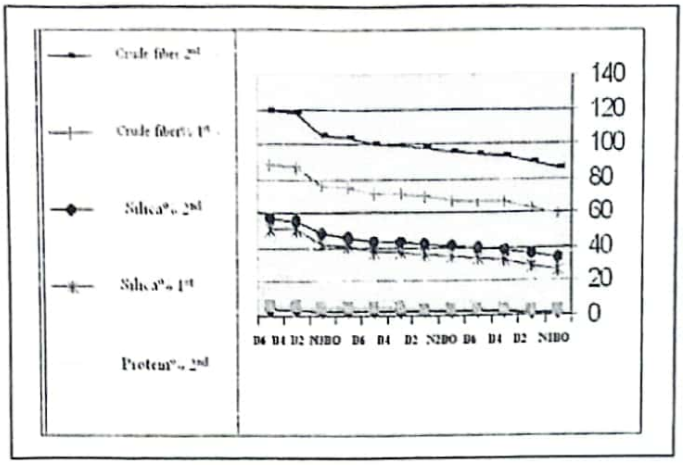


Fig (9c). Effect of the interaction between biogas manure and macro-elements (NPK) fertilizer on the percentage of N, protein, silica and crude fiber at the first and second cuts in 2002 season.

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تأثير سماد البيوجاز العضوي مع السماد المعدني المركب (ن: فو: بو) على محصول الدخن وجودته بجنوب سيناء

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أجريت تجربتان حقليتان بمحطة بحوث راس سدر التابعة لمركز بحوث الصحراء بمحافظة جنوب سيناء خلال موسمين زراعيين متتالين ٢٠٠١ و ٢٠٠٢ لدراسة تأثير التوافق ما بين مستويات من سماد البيوجاز العضوي بمعدلات ٢،٤،٦طن/فدان مقارنة بدون تسميد عضوي مع السماد المعدني المركب (ن : فو٢ا٥: بو٢ا) بمعدلات (٤:١٢:٢٠) و (٨:١٦:٢٤) و(١٢:٢٠:٢٨كجم / فدان) على حشتان من محصول الدخن وجودته بعد ٦٠ يوما من الزراعة و ٦٠ يوم من الحشة الأولى و الذي تم رية ببئر تصل درجة ملوحته ٤٢٤٩ جزء في المليون في الموسم الأول و ٤٤٤٢ جزء في المليون في الموسم الثاني. وأوضحت الدراسة النتائج التالية:

١. زاد ارتفاع النبات والوزن الغض والجاف للنبات بزيادة التسميد بسماد البيوجاز من ٢ إلى ٦ طن /فدان وكذلك بالنسبة للسماد المعدني من ٢٠:١٢:٤ إلى ٢٤:١٦:٨ بعد ستون يوما من الزراعة.
٢. أعطت المعاملة ٦ طن من سماد البيوجاز + (٢٠ ن : ١٢ فو٢ا٥ : ٤ بو٢ا) أعلى ارتفاع للنبات وأثقل وزن غض وجاف للنبات بعد ستون يوما من الزراعة .
٣. زاد المحصول الغض والجاف للفدان بزيادة التسميد بسماد البيوجاز من ٢ إلى ٦ طن/فدان وكذلك بالنسبة للسماد المعدني المركب من (٢٠:١٢:٤) إلى (٢٤:١٦:٨).
٤. أعطت المعاملة ٦ طن للفدان سماد البيوجاز + (٢٠ ن :١٢ فو٢ا٥ : ٤ بو٢ا) أثقل محصول غض وجاف.
٥. زادت نسبة النتروجين، البروتين الخام، الفسفور، الألياف الخام وقلت نسبة السيليكا بزيادة التسميد بسماد البيوجاز من ٢ إلى ٦ طن /فدان وكذلك بالنسبة للسماد المعدني المركب من (٢٠:١٢:٤) إلى (٢٨:٢٠:١٢ كجم / فدان).
٦. أعطت المعاملة ٦ طن /فدان + (٢٨ ن: ٢٠فو٢ا٥: ١٢بو ٢ا كجم/ فدان) أعلى نسبة من التحليلات الكيماوية (النتروجين، البروتين الخام، الفسفور، الألياف الخام) تحت الدراسة ماعدا نسبة السيليكا.
٧. بالنسبة للاراضى الجديدة وخصوصا المتأثرة بالأملاح والتي تروى من الآبار بمنطقة جنوب سيناء أوصت الدراسة أن يضاف للتربة قبل الزراعة سماد البيوجاز بمعدل ٦ طن/فدان لتحسين المحصول والتربة وهذا يؤدى إلى تقليل كمية السماد المعدني المركب (ن: فو: بو) توفيرا للمال وخوفا من تلوث هذه الأراضي بتراكم الأسمدة المعدنية فيها نتيجة تركيز الأملاح بها.