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Productivity and Quality of Forage Sudangrass as Affected by Mineral, Organic and Bio- Fertilizers Application Rates under Saline Soil Conditions

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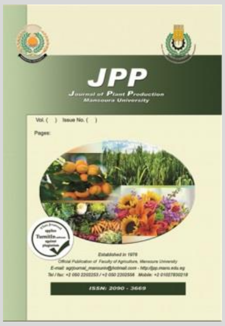

ABSTRACT

Two field experiments were carried out at El-Serw Agriculture Research Station, Damietta Governorate. ARC, Egypt, during the two seasons of 2019 and 2020 to study ways to decrease the environmental pollution and developing the most proper combination of mineral, organic and bio-fertilizers to increase productivity and quality of sudangrass "hybrid 102" also economic evaluation of studied treatments. Treatments were distributed in a Randomized Complete Block design in 3 replicates as follows: T_1 (recommended NPK 100%), T_2 (75% of NPK + 3 ton fed^{-1} compost) ,T_3 (75% of NPK + humic acid), T_4 (75% of NPK + bio fertilizer), T_5 (75% of NPK + 3 ton fed^{-1} compost+ humic acid + bio fertilizer),T_6 (50 % of NPK+ 6 ton/ fed Compost), T_7 (50% of NPK+ humic acid), T_8 (50% of NPK + bio fertilizer) and T_9 (50% of NPK +6 ton fed^{-1} compost+ humic acid + bio fertilizer), Data over both seasons declared that the fertilization affected significantly all traits. Using T_5 recorded the highest values of growth; yield and quality, treatment T_1 rank second. Whereas, the lowest values were obtained from T_6. A feasibility study proved that forage is economically advisable under treatment T_5, where net farm return per year and net return per invested one L.E. were 22973.4 and 2.56 L.E., respectively. Integrating organic and bio-fertilizers with mineral fertilization are economically better than using the recommended mineral fertilization only (100-150-50 kg/fed N-P-K respectively). It is possible to replace 25% from NPK with or mixture with organic and biofertilization

***Keywords*: Forage sudangrass, mineral fertilization, organic fertilizer, bio-fertilizer, quality and economic evaluation.

INTRODUCTION

Sudangras (*Sorghum sudanense* L.) is one an important summer forage crops in Egypt especially in Delta. Moreover, sudangrass is high fodder fresh yield and its quality. It has excellent growing habit, quick growing re-growth after cutting and better palatability, digestibility, ratoonability and various forms of its utilization like green chop, silage and hay (Dahiya *et al.*, 1997). Also, sudangrass can adapt to a wide range of soil and climatic conditions. In Egypt, increasing forage crop productivity per unit area during the summer season especially in the most newly reclaimed affected salt soils become the back bone to solve this problem. Forage sudangrass is a summer forage crop which can be cultivated in the newly reclaimed lands to overcome this problem.

Soil fertility and mineralization are major environmental factors affecting development, function, and metabolism of the plant. Fertilization of NPK are the most abundantly acquired mineral elements by plants, and they play vital roles in many aspects of plant metabolism. However, excessive use of them causes acute diseases, deterioration in soil structure and environmental pollution, especially of freshwater springs worldwide (Yolcu *et al.*, 2011). Therefore, considerable interest has been generated regarding the use of organic materials on agricultural lands for restoring soil fertility and sustainability and for preventing potential environmental problems such as water quality degradation, air pollution and dispersal of pathogenic organisms caused by the overuse of mineral fertilizers (Barton and Schipper, 2001 and Sharpe *et al.*, 2004).

Bio-stimulants can be produced from a numerous of organic or microbial sources and have been showed to enhance soil structure, root development, and nutrient uptake in a number of agricultural crops. There is a widespread belief that plants grown in organic settings are richer in secondary metabolites than traditionally grown plants (Adam, 2001).

The uses of organic manure as compost in agriculture are widely extended in Egypt. Therefore, the technology for recycling farm by-product, under intensive cropping system should be developed to maintain soil fertility level and to increase the crop yield (Tolessa and Friesen, 2001). In addition, Singh *et al.* (2006) reported that the use of organic materials as compost is an effective and eco-friendly approach for reducing the large volume of organic waste and nutrients stored in them are returned to soil. It is not only reduce the dependence on chemical fertilizer, but also improves soil structure, promotes the growth and activity of mycorrhizae and other beneficial soil organisms, alleviates the deficiency of secondary and micronutrients, sustains higher productivity due to improved soil health.

Moreover, Rashad *et al.* (2011) studied five types of composts and reported a positive impact as it improved the soil properties, ameliorated the plant growth, enhanced nutrient's uptake. They also reported that compost used at the rate of 5% was good nutrient supplier equal to or surpasses the mineral fertilizer at the recommended dose as indicated by the improvement of different plant growth criteria and nutrients uptake. Increasing compost application rate resulted in parallel significant enhancement. Also, Fouda and El-

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Agazy (2020) declared that soil fertility increased by using compost, particularly the light textured soils.

Humic acid is a commercial product contains numerous elements which improve the soil fertility and increase availability of nutrients and consequently increase plant growth and yield. It is particularly used to ameliorate or reduce the negative effect of salt stress. Sangeetha *et al.* (2006) stated that humic acids in the soil have multiple effects that can greatly benefit plant growth. Moreover, Kadam and Wadje (2011) found that potassium humate significantly increased growth and yield characters of soybean and black gram plants more than the control plants.

Biofertilizer plays vital role in conserving long term soil fertility and sustainability by fixing atmospheric di-nitrogen (N=N), mobilizing fixed macro and micro nutrients or convert insoluble phosphorus in the soil into soluble forms available to plants, thereby surpassing their efficiency and availability. Biofertilizer are eco-friendly and have been proved to be effective and economical alternate of chemical fertilizers with lesser input of capital and energy (Youssef and Eissa, 2014).

The objective of this experiment was to developing the most proper combination of mineral, organic and bio fertilizers to increase the productivity and its quality of forage sudagrass and economic evaluation.

MATRIALS AND METHODS

Field experiment:

Two field experiments were conducted on clay soil at El-Serw Agric. Res. Station Farm in Damietta Governorate, Egypt, (the farm is located at 31° 22' N latitude and 31° 64' E longitude) during the two successive seasons 2019 and 2020 to study the effect of mineral fertilizer levels, organic fertilization (compost and Humic acid) and bio-fertilizer (*Azospirillum* sp.) treatments on productivity and quality of Sudangrass (*Sorghum sudanense* L.) Var. hybrid 102. Physical and chemical characteristics of the soil in experimental site were determined according to Page *et al.,* 1982 (Table 1).

Table 1. Some physical and chemical characteristics of the soil in experimental site (Mean values for the two seasons).

Soil characteristics	Means of both seasons
Particle size distribution %	
Coarse sand	1.44
Fine sand	10.33
Silt	22.28
Clay	65.95
Textural class	Clay loam
Chemical properties	
pH (suspension 1:2.5)	7.6
EC dS m^{-1} (saturated paste extract)	4.88
Organic matter (%)	0.86
CaCO3%	1.34
Available macronutrients (mg L^{-1})	
N	32
P	7.94
K	201.3

The treatments used were as follows:

- T_1= Recommended 100 % NPK fertilizer (100, 150 and 50 kg/fed respectively) as control.
- T_2= 75% of recommended NPK + 3 ton fed^{-1} compost and incorporated into the soil during seed bed preparation.
- T_3= 75% of recommended NPK + humic acid was sprayed on 3 times.
- T_4= 75% of recommended NPK + bio fertilizer (*Azospirillum* sp.).
- T_5 = 75% of recommended NPK + 3 ton fed^{-1} compost+ humic acid + bio fertilizer (*Azospirillum* sp.).
- T_6= 50% of recommended NPK + 6 ton fed^{-1} compost and incorporated into the soil during seed bed preparation.
- T_7= 50% of recommended NPK + humic acid was sprayed on 3 times.
- T_8= 50% of recommended NPK+bio fertilizer (*Azospirillum* sp.).
- T_9 =50% of recommended NPK + 6 ton fed^{-1} compost+ humic acid + bio fertilizer (*Azospirillum* sp.).

The experiment was laid out in RCBD with three replications and plot size was 12 m^2 (4.0 x 3.0 m) in both seasons. The seeds were drilled in hills 20 cm apart with 20 kg fed^{-1} seeding rate. Planting date was 18^{th} and 12^{th} May in 1^{st} and 2^{nd} seasons, respectively. The preceding winter crop for both seasons was berseem. Seeds were inoculated using bio-fertilizers mixture of nitrogen fixing bacteria and phosphorus dissolving bacteria in the form of the commercial bio-fertilizer *Azospirillum*. *Azospirillum* is produced by the Egyptian Ministry of Agriculture as inocula carried on organic peat like substances to treat seeds. Seed inoculation was performed by mixing sudangrass seeds with the appropriate *Azospirillum* using Arabic gum as adhesive material. The coated seeds were then air dried in shade for 30 minutes and sown immediately. Mineral fertilizer was using as ammonium nitrate (33.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% KO_2) at the different rates under study and divided into three equal doses. The first dose was added after 21 days from sowing, the second and the third doses were added after the first and the second cuts. Compost was added during seed bed preparation and humic acid was carried out as foliar application three times 20, 65 and 95 days from planting at rates 2 L/400 L water/fed. Some chemical characteristics of applied both compost and humic acid are illustrated in Table (2).

Table 2. Some chemical characteristics of applied compost and humic acid used in the experiment.

Analysis	Value
Compost	
Moisture %	12.0
pH (1:10)	8.02
EC dS m^{-1}	3.14
OM %	24.5
C :N	29.6 :1
Total N %	0.48
NH_4 – N mg Kg^{-1}	55.0
NO_3 – N mg Kg^{-1}	155.0
Total P %	0.38
Total K %	0.60
Humic acid	
EC dSm^{-1}	6.10
pH	5.00
Available nutrients (mg L^{-1})	
Fe	0.440
Mn	0.058
Zn	0.940
Cu	0.030

Agricultural practices were done as recommended by forage research Department. The first cut was taken after 55 days and the second after 40 days from the 1st cut, finally the 3rd cut was taken after 30 days from the second one. Data recorded at each harvest cut on five guarded plants of each experimental plot.

The following characters were measured:

1- Plant height (cm), length of the main stem from soil surface to stem-tip.
2- Number of tillers m^{-2}.
3- Stem diameter (cm).
4- Leaf/stem ratio.
5- Fresh forage yield (ton fed^{-1}) were determined for each plot and weighed in kg/ plot then converted into ton/ fed.
6- Dry forage yield (ton fed^{-1}); 100g plant representative samples from each plot were dried at 105°C till constant weight and dry matter percentage (DM %) was estimated then dry forage yield (ton fed^{-1}) was calculated.

Chemical Characters:

The following chemical constitute were studied in the second season only on dry weight basis. Plant samples were taken from each cut and then oven dried at 70 ^{0}C until constant weight, followed by fine grinding to estimate. The following characters:

1- **Crude protein (CP):** The N-contents of the sample was determined by Kjeldahl N (AOAC, 1999) and the recorded value of nitrogen was then multiplied by 6.25 (Hymowitz *et al.*, 1972).
2- **Crude fiber (CF)** contents were determined according to the methods described by Van-Soest *et al.* (1991).
3. **Ash (%);** estimated by multiplying forage dry yield x Ash%.
4. **Total carbohydrates %** was determined in the dry matter, using the method described by Dubois *et al.* (1956).

5- Total chlorophyll content of leaves:

At 100 days after sowing (DAS) total chlorophyll of leaves mg/g was determined as SPAD unit using SPAD502 apparatus (Soil and Plant Analysis Department) of Minolta Co. SPAD unit was transformed to mg/m^2 as described by Monje and Bugbee (1992) as follows:

Total chl. = 80.05+10.4 (SPAD 502).

Economic Evaluation:

Economic study involved the following parameters:

- Mean values of input variables and the total costs of crop production including fertilizer treatments and cultural practices applied during the vegetative stages of sudangrass i.e., average land. The highest values of plant rent is not included).
- Net farm income of crop for various fertilization treatments.
- Net farm return of crop production as affected by applied treatments. It's calculated as the difference between the forage yield value (according to the actual price) and the total costs.

All fertilizers and seed prices as well as the costs of all farm operations are based on the official and the actual market prices determined by the Egyptian Ministry of also reported by Galbiatti *et al.* (2011). Total costs included all values of production inputs and other general or different costs without land rent average.

Statistical Analysis:

Collected data were statistically analyzed according to Snedecor and Cochran (1991) and treatment means were compared by LSD at 0.05 level of probability. Bartlett's test was done according to Bartlett (1937) to test the homogeneity of error variance. The test was not significant for all studied traits, so, data of the two seasons were combined.

RESULTS AND DISSCUSION

Growth traits:

Mean plant height (cm), number of tillers/m^2, stem diameter (cm) and leaf/stem ratio as affected by the application of organic and bio-fertilizers under different rats of mineral fertilizers at harvest of forage sudangrass are presented in Table 3 &4.

Data of the combined analysis showed that morphological traits were reached the significance of difference at 5% by individual or mixed applications of organic and bio-fertilizer under different rats of mineral fertilizers. The highest mean values of the three cuts for plant height (147.18 cm), number of tillers/m^2 (79), stem diameter (1.66 cm) and leaf/stem ratio (0.416) were recorded in treatment T_5 (75% of recommended NPK + 3 ton fed^{-1} ton fed^{-1} compost+ humic acid + bio- fertilizer (*Azospirillum* sp.). followed by treatment T_1 (100% NPK). In contrast, the lowest values were obtained from T_6 (50% NPK + 6 ton/ fed compost). Ibrahim *et al.* (2015) found that 75% N- fertilizer plus microbin and 3 ton/ fed of compost produced the highest pearl millet plant growth. These results also harmony with that obtained by El-Sherbini *et al.* (2017) who reported that plant height and stem diameter were significantly affected by applied compost and the mineral fertilizers compared with mineral fertilizers only on sorghum cultivars. In addition, positive growth response of Sesame to bio-fertilizer application compared to mineral fertilizers was also reported by Labib *et al.* (2019).

Table 3. Plant height (cm) and number of tillers/ m^2 of sudangrass as affected by mineral fertilizer levels, organic (compost and humic acid) and bio-fertilizer (combined analysis of two seasons).

Treatments	Plant height (cm)				Number of tillers/ m^2			
	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean
T_1	136.99	140.05	138.98	138.67	75	82	77	78
T_2	101.14	104.20	103.13	102.82	64	71	66	67
T_3	118.40	121.46	120.39	120.08	68	75	70	71
T_4	129.40	132.46	131.39	131.08	72	79	74	75
T_5	145.50	148.56	147.49	147.18	76	83	78	79
T_6	97.64	100.70	99.63	99.32	63	70	65	66
T_7	107.70	110.76	109.69	109.38	66	73	68	69
T_8	126.50	129.56	128.49	128.18	70	77	72	73
T_9	132.87	135.93	134.86	134.55	73	80	75	76
LSD 0.05	5.41	6.83	5.76	7.03	0.89	0.65	0.78	0.87

Where T_1= 100 % NPK T_2= 75% NPK + 3 ton fed^{-1} **compost**
T_3= 75% NPK + humic acid T_4= 75% NPK + bio -fertilizer
T_5 = 75% NPK + 3 ton fed^{-1} **compost+ humic acid + bio- fertilize**
T_6 = 50% NPK + 6 ton fed^{-1} **compost**
T_7= 50% NPK + humic acid T_8 = 50% NPK + bio- fertilizer
T_9 = 50 % NPK + 6 ton fed^{-1} **compost+ humic acid + bio- fertilizer**

However, the remarkable increase in plant growth attained by bio and organic fertilization can increase the organic carbon and induce the microorganism's activity for providing nutrients as nitrogen and phosphorus in the soil (Abdullahi *et al.*, 2013).

Treatments with an application of NPK combination with organic and/ or biofertilizer gave higher values of growth traits compared to sole mineral fertilizers. These results are in agreement with the findings by Saleem (2010) who reported that 50% poultry manure+ 50% chemical gave the tallest plants and leaf/stem ratio compared to control plots in the corn-legume inter cropping plants. Where, organic matter in the compost applied may lead to an improvement for aeration and consequently an optimal root growth, thereby an increase in the nutrient uptake and growth.

Table 4. Stem diameter (cm) and leaf/stem ratio of sudangrass as affected by mineral fertilizer levels, organic (compost and humic acid) and bio-fertilizer (combined analysis of two seasons).

Treatments	Stem diameter (cm)				Leaf/stem ratio			
	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean
T_1	1.34	1.81	1.57	1.57	0.351	0.447	0.374	0.391
T_2	0.97	1.37	1.13	1.16	0.25	0.346	0.273	0.289
T_3	1.02	1.49	1.25	1.25	0.265	0.361	0.288	0.305
T_4	1.12	1.59	1.35	1.35	0.291	0.387	0.314	0.331
T_5	1.43	1.9	1.66	1.66	0.376	0.472	0.399	0.416
T_6	0.84	1.23	0.99	1.02	0.237	0.333	0.26	0.277
T_7	0.94	1.41	1.17	1.17	0.254	0.35	0.277	0.294
T_8	1.07	1.54	1.3	1.30	0.288	0.384	0.311	0.328
T_9	1.15	1.62	1.38	1.38	0.339	0.435	0.362	0.379
$LSD_{0.05}$	0.04	0.03	0.03	0.03	0.007	0.006	0.006	0.005

Where T_1= 100 % NPK T_2= 75% NPK + 3 ton fed^{-1} **compost**
T_3= 75% NPK + humic acid T_4= 75% NPK + bio -fertilizer
T_5 = 75% NPK + 3 ton fed^{-1}**compost+ humic acid + bio- fertilize**
T_6 = 50% NPK + 6 ton fed^{-1}**compost**
T_7 = 50% NPK + humic acid T_8 = 50% NPK + bio- fertilizer
T_9 = 50 % NPK + 6 ton fed^{-1} **compost+ humic acid + bio- fertilizer**

Fresh and dry yields:

Fresh and dry yields data as affected by organic and biofertilizers were shown in Table 5 under different levels of mineral fertilizers, where it was ranged from 13.207 to 26.632 ton/ fed and 2.772 to 9.690 ton/ fed of the combined data for both of total fresh and dry yields, respectively. The T_5 gave the highest values of total fresh and dry yields compared with the other treatments. From the statistical analysis it was observed that application of organic and bio-fertilizers promoted growth and possessed the best yield of plant. It may be recommended the treatment of 75% NPK plus compost, humic acid and bio-fertilizers which produced high mass production under such condition. These results are in consistence with the finding of Siam *et al.* (2016) and El-Sherbini *et al.* (2017) who reported that mineral fertilizers at 50, 75 and 100% treatments led to increasing fresh and dry weights and gave the highest value was obtained by 75% with organic fertilizers.

As well as, the enhancement effect of organic and bio-fertilizers manure on sudangrass growth and yield may be due to the contribution made by amendments to fertility status of the soils as which were low in organic carbon content. Manure when decomposed increases both macro and micro nutrients and enhances the physio-chemical properties of the soil for the betterment of growth Aspasia *et al.* (2010).

Mahmood *et al.* (2017) who reported the use of 50% NPK with 50% poultry manure (resulted in maximum grain and biological yields in maize. In addition, Subash and Rafath (2016) noticed that the bacterial inoculum of Azospirillum gave a maximum value of fresh and dry yields of sesame plant. Also, Warman and Cooper (2000) mentioned that compost may reduce crop yields of mixed forage crop as compared with N, P and K fertilization due to limited nutrient availability, but soil reserve of N, P and K (and other nutrients) will be of increased after repeated amendment application.

Table 5. Fresh and dry yields (ton/ fed) of sudangrass as affected by mineral fertilizer levels, organic (compost and humic acid) and bio-fertilizer (combined analysis of two seasons).

Treatments	Fresh yield (ton fed^{-1}.)				Dry yield (ton fed^{-1}.)			
	First cut	Second cut	Third cut	Total	First cut	Second cut	Third cut	Total
T_1	7.278	9.074	8.585	24.937	2.086	3.194	2.961	8.241
T_2	4.013	5.809	5.320	15.142	0.591	1.699	1.466	3.756
T_3	4.916	6.712	6.223	17.851	0.985	2.093	1.86	4.938
T_4	6.059	7.855	7.366	21.280	1.582	2.69	2.457	6.729
T_5	7.843	9.639	9.150	26.632	2.569	3.677	3.444	9.690
T_6	3.368	5.164	4.675	13.207	0.263	1.371	1.138	2.772
T_7	4.369	6.165	5.676	16.210	0.774	1.882	1.649	4.305
T_8	5.384	7.180	6.691	19.255	1.239	2.347	2.114	5.700
T_9	6.751	8.547	8.058	23.356	1.834	2.942	2.709	7.485
$LSD_{0.05}$	0.439	0.507	0.414	0.512	0.215	0.295	0.187	0.232

Where T_1= 100 % NPK T_2= 75% NPK + 3 ton fed^{-1} **compost**
T_3= 75% NPK + humic acid T_4= 75% NPK + bio -fertilizer
T_5 = 75% NPK + 3 ton fed^{-1} **compost+ humic acid + bio- fertilize**
T_6 = 50% NPK + 6 ton fed^{-1} **compost**
T_7 = 50% NPK + humic acid T_8 = 50% NPK + bio- fertilizer
T_9 = 50 % NPK + 6 ton fed^{-1} **compost+ humic acid + bio- fertilizer**

Chemical Characters:

Data presented in Tables 6 &7 indicated the effect of mineral fertilizer levels, organic (compost and Humic acid) and bio-fertilizer (*Azospirillum* sp.) on sudangrass forage quality parameters i.e. crude protein, crude fiber, Ash carbohydrate% and total chlorophyll which were significantly affected by individual or mixed applications of organic and bio- fertilizers with different rats of mineral fertilizers. The values were ranged from 7.15 to 12.49 % for crude protein content and from 18.39 to 24.77 % for crude fiber. Ash and carbohydrate (%) contents were ranged significantly from 7.39 to 11.55 % for ash, while the values of carbohydrate were a ranged between 31.15 to 38.64%. Also, the value of total chlorophyll was ranged from 29.11 to 36.6 mg/m^2. T_5 treatment showed superiority for all studied traits as compared to other treatments, while, T_6 (50% NPK + 6 ton/ fed compost) was recorded the lowest value of the same studied traits. These findings are in harmony with those reported by Amandeep (2012) and Abou-Amer and Kewan, (2014).

Table 6. Crude protein (CP %) and crude fiber (CF %) of sudangrass as affected by mineral fertilizer levels, organic (compost and humic acid) and bio-fertilizer in the second season.

Treatments	Crude protein percentage				Crude fiber percentage			
	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean
T_1	10.88	11.36	13.25	11.83	22.78	24.53	25.06	24.12
T_2	6.67	7.15	9.04	7.62	18.56	20.31	20.84	19.90
T_3	8.69	9.17	11.06	9.64	19.14	20.89	21.42	20.48
T_4	10.02	10.5	12.39	10.97	21.56	23.31	23.84	22.90
T_5	11.54	12.02	13.91	12.49	23.43	25.18	25.71	24.77
T_6	6.2	6.68	8.57	7.15	17.05	18.8	19.33	18.39
T_7	7.08	7.56	9.45	8.03	18.97	20.72	21.25	20.31
T_8	9.09	9.57	11.46	10.04	19.54	21.29	21.82	20.88
T_9	10.41	10.89	12.78	11.36	22.29	24.04	24.57	23.63
$LSD_{0.05}$	0.52	0.52	0.37	0.47	0.41	0.42	0.29	0.63

Where T_1= 100 % NPK T_2= 75% NPK + 3 ton fed^{-1} **compost**
T_3= 75% NPK + humic acid T_4= 75% NPK + bio -fertilizer
T_5 = 75% NPK + 3 ton fed^{-1} **compost+ humic acid + bio- fertilize**
T_6 = 50% NPK + 6 ton fed^{-1} **compost**
T_7 = 50% NPK + humic acid T_8 = 50% NPK + bio- fertilizer
T_9 = 50 % NPK + 6 ton fed^{-1} **compost+ humic acid + bio- fertilizer**

Mahmud *et al.* (2003) declared that application of mixing organic and inorganic fertilizer led to increasing the crude protein, crude fiber and ash yield in forage sorghum. They also reported that good plant nutrients may not only affect the forage production but also enhance sudangrass quality. The integrated use of organic nutrient sources with inorganic fertilizer was shown to increase the potential of organic fertilizer by increasing the soil character, nutrient uptake and reducing the effects of toxic elements Li *et al.* (2021).

Such findings are referred to organic role in improving soil physical and chemical properties and providing the energy for microorganism activity and increase the availability and uptake of N, P and K (Escalada and Ratilla, 1998 and Romero *et al.* 2000). In this respect, Fouda and El-Agazy (2020) indicated that adding compost and biochar significantly increased total chlorophyll of sudangrass leaves. They explained such finding may be due to that organic fertilizer activates the enzymes involved in the formation of leaf pigments.

Table 7. Ash%, carbohydrate (%) and total chlorophyll of leaves (mg/g f.w) of sudangrass as affected by mineral fertilizer levels, organic (compost and humic acid) and bio-fertilizer in the second season.

Treatments	Ash%				Carbohydrate (%)				Total Chlorophyll of leaves (mg/g f.w)			
	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean
T_1	9.88	11.42	12.03	11.11	36.85	38.21	39.92	38.32	35.35	36.21	37.31	36.29
T_2	6.47	8.01	8.62	7.7	32.76	34.12	35.83	34.24	31.26	32.12	33.22	32.20
T_3	8.06	9.6	10.21	9.29	34.65	36.01	37.72	36.13	33.15	34.01	35.11	34.09
T_4	8.59	10.13	10.74	9.82	35.54	36.9	38.61	37.02	34.04	34.9	36.01	34.98
T_5	10.32	11.86	12.47	11.55	37.16	38.52	40.23	38.64	35.66	36.52	37.62	36.60
T_6	6.16	7.7	8.31	7.39	29.67	31.03	32.74	31.15	28.17	29.03	30.13	29.11
T_7	7.73	9.27	9.88	8.96	34.12	35.48	37.19	35.60	32.61	33.48	34.58	33.56
T_8	8.31	9.85	10.46	9.54	35.05	36.41	38.12	36.53	33.55	34.41	35.51	34.49
T_9	9.26	10.8	11.41	10.49	35.92	37.28	38.99	37.40	34.42	35.28	36.38	35.36
$LSD_{0.05}$	6.12	6.12	7.04	6.14	1.02	1.02	1.21	1.08	0.25	0.25	0.24	0.26

Where T_1= 100 % NPK T_2= 75% NPK + 3 ton fed^{-1} **compost T_3= 75% NPK + humic acid T_4= 75% NPK + bio -fertilizer**
T_5 = 75% NPK + 3 ton fed^{-1} **compost+ humic acid + bio- fertilize T_6 = 50% NPK + 6** ton fed^{-1} **compost T_7 = 50% NPK + humic acid**
T_8 = 50% NPK + bio- fertilizer T_9 = 50 % NPK + 6 ton fed^{-1} **compost+ humic acid + bio- fertilizer**

Economic Evaluation:

Data in Table (8) proved that the economic returns for combined seasons. The net return values for treatment ranged from 6998.4 LE to 22973.4 LE. Data reveal that the highest net return was achieved (22973.4 L.E.) from treatment T_5 (75% NPK + 3 ton fed^{-1} compost + humic acid + bio-fertilizer) followed by the recommended NPK (21074.4 L.E.) then treatment T_9 (50% NPK + 6 ton fed^{-1} compost+ humic acid + bio- fertilizer) (19067.2 L.E.). On the other hand, the lowest net return was (6998.4 L.E.) recorded by T_6 (50% NPK + 6 ton fed^{-1} compost) and net invested Egyptian pound. But, the highest net return per one invested L.E. 2.56 L.E. was achieved from application 3 ton fed^{-1} compost, humic acid and bio- fertilizer with 75% NPK fertilization (22973 L.E.) Similar results were obtained by Singh *et al. (*2021).

Table 8. Estimates of costs for inputs farm operations and economic return of sudangrass as affected by mineral fertilizer levels, organic (compost and humic acid) and bio-fertilizer (combined analysis of two seasons)

Costs of production inputs	Treatment								
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
				Land proparation					
Tillage	500	500	500	500	500	500	500	500	500
Planting	350	350	350	350	350	350	350	350	350
Seeds	700	700	700	700	700	700	700	700	700
Irrigation	550	550	550	550	550	550	550	550	550
				Mineral fertilizers					
Amonium nitrate (33.5% N)	500	375	375	375	375	250	250	250	250
Superphosphate (15.5% P_2O_5)	200	175	175	175	175	100	100	100	100
Potassium sulphate (48% K_2O)	300	225	225	225	225	150	150	150	150
Compost	----	250	----	----	250	500	----	----	500
Humic- acid	----	----	100	----	100	----	100	----	100
Bio-fertilizers	----	----	----	10	10	----	----	10	10
Hoeing and weeding	300	300	300	300	300	300	300	300	300
Harvesting	600	600	600	600	600	600	600	600	600
				Total variable cost					
Yield ton fed^{-1}	24.937	15.142	17.851	21.280	26.632	13.207	16.210	19.255	23.356
Price ton^{-1}	1500	1500	1500	1500	1500	1500	1500	1500	1500
Total revenue	29924.4	18170.4	21421.2	25536	31958.4	15848.4	19452	23106	28027.2
Net return	21074.4	9295.4	12696.2	16901	22973.4	6998.4	11002	14746	19067.2
Return of invested L.E.	3.38	2.05	2.46	2.96	3.56	1.79	2.30	2.76	3.13
Net return of invested L.E.	2.38	1.05	1.46	1.96	2.56	0.79	1.30	1.76	2.13

CONCLUSION

Reducing the use of mineral fertilizers in order to reduce the pollution of deep water soil and its resources also crops, increase yield efficiency and accomplish the goals of sustainable agriculture, it is recommended to use organic, bio and mineral fertilizers simultaneously. In general, it could be stated that to increase forage production and its quality of sudangrass, mineral with organic and bio-fertilizer should be used at rate of 75% NPK mineral fertilizers+ 3 ton fed^{-1} compost+ humic acid + bio- fertilizer under El- Serw soil conditions.

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انتاجية وجودة حشيشة السودان وتأثرها بمعدلات استخدام الأسمدة المعدنية والعضوية والحيوية تحت ظروف التربة الملحية

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قسم بحوث محاصيل العلف ـ معهد بحوث المحاصيل الحقلية ـ مركز البحوث الزراعية بالجيزة- مصر

تلعب تغذية النبات دورًا مهمًا في إنتاج المحاصيل وتلوث البيئة. قد يكون الاستخدام التكميلي للأسمدة العضوية والحيوية طريقة عملية لتحسين الخواص الكيميائية والفيزيائية والبيولوجية للتربة. ولذلك تم إجراء تجربتين حقليتين بمحطة بحوث السرو الزراعية بمحافظة دمياط. مركز البحوث الزراعية ، مصر ، خلال الموسمين الزراعيين الصيفيين 2019 و 2020 وذلك لدراسة طرق النقص من التلوث البيئي والوصول الي التركيبة الأمثل من الأسمدة المعدنية والعضوية والحيوية لزيادة إنتاجية وجودة علف حشيشة السودان (هجين 102) وكذلك التقييم الاقتصادي للمعاملات المدروسة. كان التصميم التجريبي المستخدم قطاعات كاملة العشوائية بثلاثة مكررات. الدراسة تمت فى تسع معاملات هى T_1 المصدر المعدنى NPK بصورة منفردة 100% من الموصى به ، T_2 = (75 % NPK + 3 طن / فدان كمبوست)، T_3 =(٪ 75 NPK + حمض الهيومك)، T_4 =(75٪ NPK + سماد حيوي) ، T_5 = (75٪ NPK + 3 طن / فدان كمبوست + حمض الهيوميك + سماد حيوي) ، T_6 = (50٪ NPK + 6 طن / فدان كمبوست)، T_7 = (50٪ NPK + حمض الهيوميك) ، T_8= (50٪ NPK + سماد حيوي) ، T_9 = (50٪ NPK + 6 طن / فدان كمبوست + حمض الهيوميك + سماد حيوي) ، أوضح التحليل التجميعى للبيانات على مدار الموسمين أن الصفات المدروسة قد تأثرت معنوياً بمعاملات التجربة. حيث أعطت المعاملة T_5 أعلى قيم صفات النمو والمحصول وجودة لحشيشة السودان. تليها المعاملة T_1 . على العكس من ذلك ، تم الحصول على أقل القيم من المعاملة T_6 . أثبتت الدراسة الاقتصادية أن علف حشيشة السودان مستحسن اقتصاديًا تحت المعالجةT_5 ، حيث صافي عائد المزرعة سنويًا وصافي العائد لكل جنيه واحد مستثمر 22973,4 جنيهاً و2,56 جنيهاً على التوالي. لذلك يعتبر دمج الأسمدة العضوية والحيوية مع التسميد المعدني أفضل اقتصاديًا من استخدام التسميد المعدني الموصى به فقط (100-150-50 كجم / فدان N-P-K على التوالي). يمكن احلال 25٪ من التسميد المعدني الموصى به NPK بمزيج من التسميد العضوي والحيوي.