Effect of NP Fertilization Levels on Sorghum (*Sorghum bicolor L.*) Yield and Fodder Quality for Animals

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Received on: 3/3/2014 *Accepted: 24/3/2014*

ABSTRACT

Two experiments were conducted on fodder sorghum. The first was a field study to determine the effect of NP fertilization levels on sorghum (*Sorghum bicolor L.*) yield and the second was to determine sorghum quality as green fodder for Brki sheep. This work was carried out at Maryout Research Station-Desert Research Center, Egypt, during the summer growth season of 2012. Sorghum seeds were sown with different fertilization levels of N (0, 100, 120 kg N/fed) and P (0, 30, 40 Kg P_2O_5/fed). Nitrogen fertilizer was applied in four equal doses. Phosphorus was mixed with organic manure and supplied as a single application. However, organic fertilizer was added to all treatments at rate of 8 m^3 and also potassium at rate of 50 Kg K_2O/fed. The results showed that application of the highest rates of N and P increased the fodder, grain sorghum yields and improved the fodder quality. In addition, this treatment increased the soil and plant mineral content of N and P as well as sheep performance. Economic analysis showed that all fertilizer treatments had a increased in marginal rate of return (MRR) and decreased in values cost ratio (VCR) compared to the control treatment. Moreover, the application of N and P at the highest rates gave the maximum of marginal return per unit of investment with reduce the values of cost ratio. Based on these results, application of 120 kg N and 40 kg P_2O_5/fed can be recommended for maximizing sorghum productivity as well as animal fed and farmers' income in the study area and similar regions in Egypt.

Key words: N, P, Sorghum fodder, grain yield, quality, mineral content, Barki lambs

INTRODUCTION

Fertilizers constitute an integral part of improved crop production technology. The proper amount of fertilizer application is considered a key to the bumper crop production. (Tariq *et al*., 2007). Therefore, management of fertilizing is important to increasing crop productivity. On the other hand, using fertilizer is profitable until yield increasing rate supply fertilizer cost. Using much N can resulted in problems such as much cost, soil degradation and environment pollution (Alcoz. *et .al*, 1993). Many researchers have pointed to the need for cereal crops to relatively high levels of N and sufficient amounts of P.

Nitrogen is the essential element required for plant growth in relatively large amounts. N deficiency can result in reduced dry matter, crude protein and grain yield (Ashiono *et al*., 2005). In fodder crop, as the N fertilizer increased, crude protein increased while crude fiber present decreased which could increase palatability and digestibility. Therefore, it seems that application of N fertilizer could increase palatability and digestibility of fodder. On the other hand, amount of soluble carbohydrates also could alter the quality of the forages (Almodares. *et. al.,* 2009). In addition, P is another essential nutrient required to increase plant yield. Consequently, the lack of P is important as the lack of N in limiting plant performance. Phosphorus application is important which directly contributes to the quality and quantity of fodder production, (Roy and Khandaker, 2010). In this respect, Mousavi, *et. al.* (2012) recommended the apply of 135 to 225 kg N ha^{-1} to sorghum plants. Also, Jiang *et al.* (2006) recommended applying 108 kg P ha^{-1}.

Sorghum (*Sorghum bicolor L.*) is one of the most widely adapted forage crops and grown extensively during summer season and has a significant role in livestock production (Amandeep, 2012). In this respect, livestock is an important sector in newly reclaimed soils of Egypt. There is need to emphasize for increased fodder production so that we could provide more support to livestock industry. Feeding of green forage to livestock is essential for the maintenance of normal health and reproduction (Roy and Khandaker, 2010). Little research in the recent past has been carried to find out the profitability of sorghum as green fodder in newly reclaimed land in Egypt, spite of the ever-increasing demands and its economic importance. However, the production of sorghum fodder could be increased by the application of balanced fertilizer in particular with the use of N and P fertilizers as its quality can be considerably improved with these nutrients. Therefore, the purpose of this study was to investigate the effect of NP fertilization levels on sorghum yield and fodder quality for animals.

MATERIALS AND METHODS

The investigation was conducted at Maryout Research Station, Desert Research Center (DRC), at longitude 29° 47' and 10° 30" E and latitudes 31° 0' and 15° 46" N, during the summer growth season of 2012. This work comprised two experiments as follows:

Experiment 1: A field experiment was designed and planted through summer season of 2012. The seed of sorghum was sown in sandy clay loam soil (76.39% sand, 12.65 % silt and 10.96% clay) having pH 7.42, EC 5.50 dS/m^{-1}, total $CaCo_3$ 28.48 and organic matter 1.03 %. The available N, P and K in the soil were 19.10, 5.42 and 46.12 mg/kg^{-1}, respectively. The experiment was conducted by using three levels of N and P fertilizer (0, 100, 120 Kg N and 0, 30, 40 Kg P_2O_5/ fed) in a randomized complete block design, with 5 treatments using three replicates. The plot size was 150 m^{-2}(1/28 fed) and the experiment irrigated by flood irrigation system. Ammonium nitrate (33.5 % N) and superphosphate (15.5% P_2O_5) were used as fertilizer source of N and P elements. N was applied in four equal splits in last April (10 kg N/fed) as active does before sowing and then after first, second and third cuttings of each season, whereas, P fertilizer mixed with organic manure and applied annually before sowing. However, farmyard manure was added to all treatments at rate 8 m^3 and also potassium at rate 50 kg K_2O/fed. Fodder green yield was recorded at end of all cuttings and were weighed and recorded in kg/plot. Plant samples fresh weight was then air-dried to determine the dry weight. Also, to determine grain yield per panicle and grain yield/fed, five plants were randomly selected from middle of each plot and harvested at physiological maturity. Then, washed with tap water, followed by distend water and oven-dried at 70°C for 72 hr., and the grain yield was measured. Plant samples were washed, dried at 60 ˚C, and total of N, P, crude fiber and crude fat were determined according to AOAC (2000). Soil samples were collected from each plot at 0-30 cm depth after the harvest of all cuttings, mixed, air-dried and ground to pass a 2-mm sieve. Available N, P and K in soil were determined according to Black *et al,* (1982).

Experiment 2: This experiment was carried out during the period from mid-June to last October 2012, with the same sorghum variety experiment practices at Maryout Research Station, to study the effect of the fertilizer levels of N P on daily gain and changes of body weight of Barki lambs as test animals. Thirty Barki male lambs (initial body weight 18.5 ± 3 kg at the age of 5 months) were randomly divided into five equal groups (6 lambs/ group) for a period of 120 days. Diets fed to lambs is consisted of 40% chopped fodder sorghum treated by P_0N_0, N_1P_1, N_1P_2, N_2P_1, N_2P_2 and 60% commercial concentrate mixture on based of 4% from the body weight. Lambs were housed in shaded pens and fed twice a day (at 09:00 and 15:00 h) and they had free access to fresh water and vitamin/mineral block over the experimental period. Lambs were given a 2-week adaptation period to the pens before receiving the experimental diets. Lambs were weighed at the beginning of the study and biweekly, thereafter, before the morning feeding throughout the study. Lambs average daily gain was calculated by subtracting initial from final BW and then dividing by the duration of study. Average dry matter intake of each group was calculated. Statistical analysis was performed according to Gomez and Gomez (1984).

The statistically significant treatments of this experiment were subjected to economic analysis using the partial-budget procedure to determine levels of N and P that would give acceptable returns at low risk to farmers. Economic analysis was done using the prices for inputs at planting and for outputs at the time the crop was harvested. All costs and benefits were calculated on a unit area basis (feddan) in Egyptian pound (LE). The following formulae were employed to find out the economic parameters as reported by CIMMYT (1988). Marginal rate of return MRR (between treatments, 1 and 2) = [change in net benefit (NB2-NB1)/change in total variable cost TVC (TVC2 – TVC1)] × 100. Thus, a MRR of 100% implies a return of one LE on every LE of expenditure in the given variable input. Value cost ratio (VCR) = Net benefit / Total variable cost (NB/TVC).

RESULTS AND DISCUSSION

Fodder yield

The results showed that the effect of N and P levels and their interactions on green fodder yield were highly significant (Table 1). At the same time, fodder yield was increased significantly by increasing N and P fertilizer levels compared to the control. However, sorghum fodder yield was higher in the fires cutting than the second and third cuttings, respectively. Maximum fodder yield were 16.98, 14.05 and 8.40 ton per fed by applying (120 Kg N and 40 Kg P_2O_5/fed) followed by 16.51, 13.46 and 8.03ton per fed by NP applied at the rate of 120 Kg N and 30 kg P_2O_5/fed in the first, second and third cutting, respectively. This may be due to increasing availability of soil nutrients with the increased in N and P fertilizer rate and positive effect of N and P elements on the production of fodder crops. Similar results were obtained by Alias *et al.* (2003) on fodder maize and Rashid and Iqbal, (2012) on fodder sorghum.

Dry matter yield

It is clear that the impact of N and P treatments and their interactions on dry matter yield were significantly higher than the control treatment, Table (1).

Table 1: The fodder, dry and grain yields of sorghum as influenced by N and P application

NP Levels (Kg/fed)	Fodder yield (t/fed)				Dry matter yield (t/fed)				Grain yield (t/fed)
	1 st cut	2 nd cut	3 rd cut	Mean	1 st cut	2 nd cut	3 rd cut	Mean	
Control	11.02	8.45	5.19	8.22	1.58	1.09	0.68	1.12	1.09
N_1P_1	15.98	12.91	7.62	12.17	2.46	2.13	1.03	1.87	1.84
N_1P_2	16.24	13.12	7.83	12.40	2.50	2.20	1.15	1.95	1.93
N_2P_1	16.51	13.46	8.03	12.67	2.60	2.26	1.21	2.02	2.01
N_2P_2	16.98	14.05	8.40	13.14	2.68	2.35	1.32	2.12	2.13
Mean	15.35	12.40	7.41		2.36	2.01	1.08		1.80
LSD (0.05)									
Treatment	0.101	0.121	0.092		0.032	0.016	0.012		0.020
Interaction	0.108	0.155	0.101		0.034	0.018	0.015		0.022

Also, the trend of dry matter yield for both NP fertilizer levels was exactly similar as was recorded for green fodder yield in three cuttings. The maximum dry matter values were 2.68, 2.35 and 1.32 ton/fed, by applying the highest rates of NP which was followed by 2.60, 2.26 and 1.21 having NP applied at the highest and lowest rates of N and P in the first, second and third cutting, respectively. These results are in line with those of Das *et al.* (1996) who observed that dry matter yield of sorghum increased with the application of P at all the stages of crop growth and boot leaf stage. Also, the above results agree with those obtained by Akmal and Asim (2002) on sorghum dry matter and Hani *et al.* (2006) on maize dry matter.

Grain yield

Table (1) showed the response of sorghum grain yield to N and P application and their interactions compared to the control. Significant increases in grain yield were observed by increasing of N and P application. Also, it is obvious were significant differences between fertilizers treatments in grain yield. The maximum grain yield of 2.13 and 2.01 t/fed, were obtained by the application of 120 kg N and 40 kg P_2O_5, and by the application of 120 kg N and 30 kg P_2O_5, respectively. The favorite effect may be due to the positive effect of NP on fodder and dry matter yields, where the grain production is the output fodder yield and dry matter. In this respect, the NP interaction clearly indicates the need of both nutrients to achieve a top yield level, which is consistent with the basic principles of plant nutrition (Marschner, 1995). Also, Johar *et al*. (2002) concluded that grain yield of maize and net returns increased with increasing in N and P fertilizer rates. The above results agree with those obtained by Ashiono *et al*. (2005).

Crude protein (%)

The data presented in Table 2, showed that the effect of N and P on crude protein content was highly significant than the control treatment. Maximum crude fiber values were 12.38, 11.52 and 10.45 by applying N_2P_2 and followed by 12.17, 11.52 and 10.12 values by N_2P_1, in the first, second and third cutting, respectively. The increases of crude protein due to the addition of N may be attributed to the beneficial effect of N on protein formation, and P application might have enhanced N fixation to be utilized by plants and ultimately increased the protein content. In this respect, (Amandeep, 2012) suggested that the increase in crude protein with increasing the N application was due to increased absorption of N. Since N is the main constituent of amino acids, it ultimately increased crude protein contents of plants. Mengel and Kirkby, (2001) showed that, the increase in crude protein content was due to the fact that P is an important structural component of DNA and RNA. Polat *et al*. (2007) reported that crude protein concentrations were significantly enhanced with increasing P fertilizer amounts. These results are in agreement with those mentioned by Afzal. *et al.* (2012).

Crude fiber (%)

Table 2 showed that the progressive increase in crude fiber was observed with the increase in N and P levels compared to the control. However, application of NP at the highest rate caused a significant decrease in crude fiber than that at the lowest rate of each. The maximum crude fiber values were 33.0, 37.30 and 40.93 by applying N_1P_1 followed by 32.98, 35.02 and 40.86 at the rate of N_2P_1, in the first, second and third cutting, respectively. This may be due to the highest rates of NP application. In this direct, Ayub *et al*. (2002) reported that the crude fiber content was significantly influenced by the application of N and P. Also, Amandeep. (2012) indicted that the application of N had depressing effect on crude fiber content because it resulted in increased leaf weight and wider leaf-stem ratio which might had decreased the crude fiber content in sorghum. It is also added also that the increase in fiber content with advancement in plant age was due to more synthesis of structural carbohydrates and deposition of fibrous material in plant.

Table 2 The content of crude protein and fiber of sorghum as influenced by N and P application

NP Levels (Kg/fed)	Crude protein (%)				Crude fiber (%)			
	1 st cut	2 nd cut	3 rd cut	Mean	1 st cut	2 nd cut	3 rd cut	Mean
Control	8.47	7.63	7.05	7.72	30.92	33.84	39.21	34.65
N_1P_1	11.85	11.06	9.78	10.89	33.00	37.30	40.93	37.08
N_1P_2	11.94	11.16	9.93	11.01	32.07	34.04	39.30	35.14
N_2P_1	12.17	11.33	10.12	11.21	32.98	35.02	40.86	36.28
N_2P_2	12.38	11.52	10.45	11.45	32.61	34.59	40.12	35.78
Mean	11.36	10.54	9.46		32.32	34.96	40.08	
LSD (0.05)								
Treatment	0.069	0.064	0.094		0.086	0.073	0.066	
Interaction	0.078	0.068	0.102		0.135	0.113	0.105	

Crude fat (%)

The data in Table, 3 indicate that there was a significant increase in fat production with the increase in NP levels. However, crude fat increase by increasing NP levels when compared to the results of crude fiber. The highest crude fat values (3.56, 2.92 and 2.66) were obtained with the highest dose of N and P applications as compared to the corresponding values (2.59, 2.45 and 2.21) with the highest rate of N and lowest rate of P, in the first, second and third cutting, respectively. This may be due to the highest doses of N and P application and increased in dry matter yield. In this respect, McDonald *et al.* (1991) reported that fiber content was decreased by application of N fertilizer. Also, Amandeep, (2012) indicated that the total production of crude fat increased due to the increase in dry matter yield and highest dose of N application.

Crude carbohydrates

The results in Table 3 showed that the application of NP fertilizer had no effect on sorghum carbohydrate content. The maximum carbohydrate values (49.83, 49.36, and 45.53) were with the control treatment, while the minimum values (42.50, 42.42, and 38.49) were obtained by the highest rate of N and P, in the first, second and third cutting, respectively. This may be due to the lowest values of crude protein, crude fiber and crude fat of control treatment, where the carbohydrate values are subtracted from the values of the previous factors (i.e. crude protein, fiber and fat) and high doses of fertilizers. The results of sorghum soluble carbohydrate content are in line with those of Almodares. *et. al*. (2009) they showed that the carbohydrate content was decreased as the level of nitrogen increased in all fodders. Application of N fertilizer decreased soluble carbohydrates content in sorghum.

Leaf mineral content of N

Data in Table (4) showed that the application of N had significant effect on leaf N content. Also, Sorghum was highest response to N application compared to the control. In addition, increase N content by increasing N application in three cuttings. The highest leaf N contents were 2.15, 2.00, 1.82 having applied by N_2P_2 treatment followed by 2.12, 1.97, and 1.76 values by N_2P_1 treatment, in the first, second and third cutting, respectively. Moreover, the interaction of P and N had a significant effect on N leaf. Mean values of the data suggested that P when applied at the highest rate of P with N resulting in maximum leaf N compared to the lowest rate of P. This may be due to the role of P in growth roots and high response of sorghum to N application. Similar results were obtained by Ashiono, *et. al,* (2005) and Abou-Amer (2007).

Table 3: The content of crude fat and Carbohydrates of sorghum as influenced by N and P application

NP Levels (Kg/fed)	Fat (%)				Carbohydrates (%)			
	1 st cut	2 nd cut	3 rd cut	Mean	1 st cut	2 nd cut	3 rd cut	Mean
Control	2.22	1.83	1.09	1.71	49.83	49.36	45.53	48.24
N_1P_1	2.31	2.08	1.96	2.12	42.72	40.39	39.40	40.84
N_1P_2	2.48	2.26	2.06	2.26	42.46	43.10	39.82	41.79
N_2P_1	2.59	2.45	2.21	2.42	42.23	42.77	38.66	41.22
N_2P_2	3.56	2.92	2.66	3.05	42.50	42.42	38.49	41.14
Mean	2.63	2.31	2.00		43.95	43.61	40.38	
LSD (0.05)								
Treatment	0.064	0.053	0.039		0.195	0.168	0.146	
Interaction	0.081	0.076	0.054		0.283	0.267	0.232	

Table 4: The content of leaf N and P of sorghum as influenced by N and P application

NP Levels (Kg/fed)	Leaf N (%)				Leaf P (%)			
	1 st cut	2 nd cut	3 rd cut	Mean	1 st cut	2 nd cut	3 rd cut	Mean
Control	1.47	1.33	1.23	1.34	0.146	0.138	0.116	0.133
N_1P_1	2.06	1.92	1.70	1.89	0.208	0.205	0.200	0.204
N_1P_2	2.08	1.94	1.73	1.91	0.210	0.206	0.204	0.207
N_2P_1	2.12	1.97	1.76	1.95	0.212	0.209	0.208	0.210
N_2P_2	2.15	2.00	1.82	1.99	0.216	0.213	0.211	0.213
Mean	1.98	1.83	1.65		0.198	0.194	0.188	
$LSD_{(0.05)}$								
Treatment	0.012	0.011	0.016		0.0010	0.0014	0.0012	0.012
Interaction	0.014	0.012	0.018		0.0011	0.0015	0.0013	0.014

Leaf mineral content of P

The data in Table 4 revealed that P content in sorghum leaves was significantly increased by P application rate. Maximum leaf P content values were 0.216, 0.213 and 0.211 by N_2P_2 treatment followed by 0.212, 0.209 and 0.208 by the N_2P_1 in the first, second and third cutting, respectively. Also, the interaction of P and N had a significant effect on leaf P. This may be due to application of N which increased plant growth and increased the absorption of other elements. Ashiono *et al*. (2005) suggested that N played a complementary role in the uptake of P. These results are in agreement with the observation of Roy and Khandaker (2010).

Soil mineral content of N

Data in Table (5) showed that the application of N to soil had significant on soil N content. Also, soil N content was highest at the first cutting compared to the second and third cuttings. This may be due to the application of N and active does with organic manure than the only N does after second and third cuttings. Maximum soil N content were 32.65, 29.53, 26.35 mg/kg soil by N_2P_2 treatment followed by 31.72, 28.78, 25.23 mg/kg soil by N_2P_1 treatment, in the first, second and third cutting, respectively. Also, application of P with N to soil had significant effect on soil N content. Similar results were obtained by (Hassan , 2003).

Soil mineral content of P

Data in Table (5) indicated that the soil content of P was significantly affected by P application compared with the control. In addition, increase soil P content by increasing P application in three cuttings. In addition, soil P content was the highest at the first cutting than the second and third cuttings. This may be due to the application of P mixed with organic manure before sowing which led to increasing in availability in P of soil. The maximum soil P contents were 9.15, 8.58, 8.13 by N_2P_2 treatment followed by 8.56, 8.25, 7.54 mg/kg soil by N_2P_1 treatment, in the first, second and third cutting, respectively. On the other side, N application with P had increased significantly soil content of P. Similar results were obtained by (Abou-Amer, 2007)

Body weight changes of lambs

The data in Tables (6) showed remarkable increase in body weight change (Kg^{-1}) of Barki lambs with increasing the N and P fertilizers applied to the fodder. Also, the interaction between of NP fertilizer rates and fodder on body weight change had a significant effect. The first cutting showed the highest live body weight changes for lambs comparing with both the second and third cuttings. This may be due to the increased of protein and fat with decreased the fiber content of sorghum fodder. Moreover, the 1st cut of fodder sorghum was the highest of P and N mineral content compared to the second and third cuttings, respectively. Sorghum fodder treated by 120 Kg N and 40 Kg P_2O_5/feddan resulted the maximum body weight change which followed by the fodder treated by 120 Kg N and 30 Kg P_2O_5/ fed, while the minimum body weight change was obtained by fodder without NP fertilizer (control treatment) in the first, second and third cutting, respectively. In this respect, Nagalakshmi, *et. al*, (2010) indicated that the feeding of roughages under complete diet system improved the palatability and utilization of bulky crop forages. Various processing methods like grinding and pelleting, improved the dry matter intake and digestibility of nutrients. Almodares. *et. al.* (2009) showed that the fodder sorghum in early stages is higher in succulent, more palatable and less percentage of crude fiber.

Lambs growth rates

As in Table 6, the effect of NP fertilizer levels and their interaction on lamb's growth rates (g/day) had a significant effect. Lambs growth rates were the highest in the first cut than the second and third cuts. Fodder fertilized by 120 Kg N and 40 Kg P_2O_5/ feddan was the highest values of growth rate (189, 169, 139 gd^{-1}) which was followed with the fodder treated by120 Kg N and 30 Kg P_2O_5/ fed, (179, 156, 128 gd^{-1}), while the lowest values of growth rate (134, 120, 103 gd^{-1}) were obtained by fodder without NP fertilizer in the first, second and third cuttings, respectively. This may be due to susceptibility of animal's growth to be fast in the first period of her life. Similar results were obtained by Jabbari, *et. al.* (2011).

Table 5: The content of available N and P in soil as influenced by N and P application

NP Levels (Kg/fed)	Soil N (mg/Kg^{-1})				Soil P (mg/Kg^{-1})			
	1 st cut	2 nd cut	3 rd cut	Mean	1 st cut	2 nd cut	3 rd cut	Mean
Control	12.93	11.86	10.20	11.66	3.96	3.59	2.80	3.45
N_1P_1	25.79	22.70	22.06	23.52	8.06	7.38	6.80	7.41
N_1P_2	26.22	23.85	22.30	24.12	8.30	8.03	7.12	7.81
N_2P_1	31.72	28.78	25.23	28.57	8.58	8.25	7.54	8.12
N_2P_2	32.65	29.53	26.35	29.51	9.15	8.56	8.13	8.61
Mean	25.86	23.34	21.23		7.61	7.16	6.48	
LSD $_{(0.05)}$								
Treatment	0.226	0.246	0.180		0.129	0.188	0.165	
Interaction	0.236	0.262	0.271		0.209	0.206	0.178	

Table 6: The body weight change and growth rate of lambs through study season as influenced by N and P application

Treatments	1 st cut			2 nd cut			3 rd cut		
	Initial B.W (Kg^{-1})	Final B.W (Kg^{-1})	Growth rate (gd-1)	Initial B.W (Kg^{-1})	Final B.W (Kg^{-1})	Growth rate (gd-1)	Initial B.W (Kg^{-1})	Final B.W (Kg^{-1})	Growth rate (gd-1)
Control	18.73	24.09	134	24.19	28.99	120	29.02	33.14	103
N_1P_1	18.69	24.29	140	24.32	29.76	136	29.78	34.41	116
N_1P_2	18.75	25.35	165	25.41	31.17	144	31.22	35.94	118
N_2P_1	18.74	25.90	179	25.99	32.23	156	32.24	37.35	128
N_2P_2	18.79	26.35	189	26.38	33.14	169	33.18	38.75	139
Mean	18.74	25.20	161	25.26	31.06	145	31.09	35.92	121
LSD $_{(0.05)}$									
Body weight		0.246			0.314			0.361	
Treatments		0.538	5.23		0.687	7.63		0.792	7.18
Interaction		0.602			0.768			0.885	

Economic analysis

Data of economic analyses (partial budgets) for fertilizer N and P use are presented in Tables 7, indicated that all treatments of NP had positive gross benefits than those of no fertilizer (control treatment). Also, changing from control to all NP treatments in that order gave highest value cost ratio (VCR) as compared with control**.** The marginal rate of return (MRR) between control treatment and the treatment of N_1P_1 was 253%. This may be due to the yields of sorghum and animal in control treatment are low in production and high in cost ratio (10.96%) than the value (5.78%) of the N_1P_1 treatment because it did not received NP fertilizer. These results are in agreement with the observation of Yinbo *et al,.* (1997) on soybean.

However, marginal rate was 265% by increasing the level of P fertilizer to the highest rate (N_1P_2) and decreased of cost ratio to 5.57% compared to treatment of N_1P_1. This may be due to the high price of P fertilizer unit. In addition, marginal rate was 426% by increasing the level of N to the highest rate (N_2P_1) with decreased of cost ratio to 5.52%. This may be due to increased fodder, grain and animal yields, and response of sorghum fodder to increasing N fertilizer. Marginal rate was 450% by increasing the highest rates of N and P than the (N_2P_1) treatment and decreased of cost ratio to (5.47) compared to (N_2P_1) treatment. The favored attributed may be due to the application of N and P at the highest rate which increased the sorghum and animal yields and both have positive effect with reduced fertilizer costs **.**So, the application of 120 Kg N and 40 Kg P_2O_5/fed was the economic optimum dose to sorghum fodder and animals that feed it. Also, gave the highest marginal rate of return for sorghum as well as animals production. The obtained results are also in trends with those Samuel, *et. al.* (2011) on sorghum, and Tolera, (2012) on maize**.**

On the other hand, It should be noted that, the input and output prices used in the economic analysis were those prevailing during the period of the experiment, and also, input or product prices are dynamic and subject to change. As such, a recalculation of the partial budget using a set of likely future prices, i.e., sensitivity analysis, is necessary to identify treatments that are likely to remain stable and sustain acceptable returns to farmers despite variability in prices (Samuel, *et. al.,* 2011).

Table 7: Economic analysis of fertilizer use for sorghum and animal yields (Prices in 2012)

Variable	NP Fertilizer levels (Kg/fed)				
	0 N 0P_2O_5	**100 N 30 P_2O_5**	**100 N 40 P_2O_5**	**120 N 30 P_2O_5**	**120 N 40 P_2O_5**
Output of three cuttings fodder yield (t/fed)	24.66	36.51	37.20	38.00	39.31
Adjust fodder yield (10%)	22.20	32.85	33.48	34.20	35.38
Field price of fodder (LE ton)	100	100	100	100	100
Gross return (LE fed)	2220	3285	3348	3420	3538
Output of grain yield (t/fed)	1.09	1.84	1.93	2.01	2.12
Adjust grain yield (10%)	0.98	1.66	1.74	1.80	1.91
Field price of sorghum grain (LE ton)	1650	1650	1650	1650	1650
Gross return (LE fed)	1617	2731	2871	2970	3157
Output of lambs yield of meat (Kg)	14.41	15.71	17.19	18.61	19.96
Adjust yield of meat 10% (Kg)	12.97	14.14	15.47	16.75	17.97
Field price of Kg meat (LE Kg)	35	35	35	35	35
Gross return animal (LE)	454	495	541	586	629
Total gross return (LE)	4291	6511	6761	6977	7324
Variable costs					
Cost of N fertilizer (LE fed)	0	450	450	540	540
Cost of P fertilizer (LE fed)	0	174	232	174	232
Cost of lobar (LE)	150	150	150	150	150
Cost of feed lambs (LE)	181	186	196	205	211
Total variable cost (TVC)	331	960	1028	1069	1133
Net benefits (NB)	3960	5551	5733	5907	6191
Values to cost ratio (VCR)	11.96	5.78	5.57	5.52	5.47
Marginal rate of return % (MRR)		253%	265%	426%	450%

Note: Yield was down adjusted with 10%, N price = 4.5، LE/ kg, P price = 5.8، LE/ kg.
Coefficient, 1$ = 6.074 LE.

Thus, we assumed a price variation of about 20%, which is realistic under the market conditions in Egypt at the time.

RECOMMENDATIONS

Based on the evidence presented in this study, the following recommendations are proposed:

1. Application rates of 120 Kg N and 40 Kg P_2O_5/fed are to be recommended for maximum of fodder, dry matter and grain sorghum yields.
2. Sorghum fodder treaded by the mentioned rates of N and P fertilizer is recommended to be feeding of Barki lambs for obtain a higher productivity of animals.

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الملخص العربى

تأثير مستويات التسميد بالنتروجين والفوسفورعلى محصول السورجم وجودة العلف للحيوانات

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أجريت تجربتان في محطة بحوث مريوط التابعة لمركز بحوث الصحراء خلال الموسم الزراعى الصيفى لعام ٢٠١٢.

التجربة الأولى:- تجربة حقلية لدراسة تأثير إضافة مستويات النتروجين والفوسفور الموصى بها على المحصول وجودة العلف والمحتوى المعدنى لنباتات السورجم.

التجربة الثانية؛- تجربة تغذية حيوان لدراسة تأثير التغذية بنباتات سورجم العلف المعاملة بمعاملات التسميد بمستويات النتروجين والفوسفور على أداء ذكور حملان أغنام البرقى لانتاج اللحوم.

شملت المعاملات السمادية إضافة النتروجين عند ثلاث مستويات وهى صفر، ١٠٠، ١٢٠ كجم ن/فدان على صورة نترات الأمونيوم و كذلك إضافة الفوسفورعند ثلاث مستويات وهى صفر، ٣٠، ٤٠ كجم P_2O_5/ فدان على صورة سوبر فوسفات الكالسيوم. تمت إضافة معاملات الفوسفورعلى دفعة واحدة مع السماد العضوى فى شهر إبريل.بينما تمت إضافة النتروجين على أربع جرعات. الأولى كانت مع السماد البلدى كجرعة منشطة ثم أضيفت ثلاث جرعات متساوية بعد كل حشة على مدار الموسم. كذلك تمت اضافة السماد العضوى والبوتاسى على صورة سلفات البوتاسيوم لجميع المعاملات.

وقد أظهرت النتائج تأثير معنوى واضح على نمو النبات عند إستخدام المستوى العالى من النتروجين والفوسفور (١٢٠ كجم نتروجين و٤٠ كجم P_2O_5 /فدان) من التوصيات، حيث أدت هذه المعاملة الى زيادة معنوية فى محصول العلف الآخضر والمادة الجافة ومحصول البذوروجودة العلف وكذلك المحتوى المعدنى للنبات بالاضافة الى زيادة معنوية فى كل من أوزان الحملان ومعدلات النمو اليومى للحيوانات.

وقد بينت نتائج التحليل الاقتصادى أن جميع معاملات التسميد أعطت زيادة لمعدلات العائد النقدى مع انخفاض فى معدلات نسبة التكاليف مقارنة بمعاملة الكنترول ولكن كان أفضلهم هى معاملة التسميد عند استخدام المستوى العالى من النتروجين والفوسفور حيث أعطت أعلى معدل للعائد لوحدة الاستثمار (الجنيه المصرى) وكذلك أقل نسبة تكاليف. من هنا توصى هذه الدراسة باستخدام هذه المعاملة (١٢٠ كجم نتروجين و٤٠ كجم P_2O_5 /فدان) للحصول على أعلى إنتاجية لكل من نبات السورجم وكذلك للحيوانات المغذاه عليه بمنطقة مريوط والمناطق المشابهة لها بجمهورية مصر العربية.