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Effect of NP Fertilizers on Growth and Biochemical Content of Sorghum Grown in Calcareous Soil

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EFFECTS of NP fertilizer levels on growth and biochemical content of sorghum fodder grown in calcareous soil was investigated in two successive seasons from 2010 to 2011. This study was carried out at Maryout Research Station-Desert Research Center, between longitude 29°47′ and 11°18′ E and latitudes 31°00′ and 15°18′ N. Levels of NP Fertilizer applications were 0, 80, 100, 120 kg N/fed and 0, 20, 30 and 40 kg P_2O_5/fed. Nitrogen was given as three split applications, whereas P was mixed with organic manure and supplied as a single application. The control treatment was the existing nutrient application of just of manure and potassium, given as a single application. However, organic fertilizer was added to all treatments at rate 10 m^3 and also potassium at rate 50 Kg KO_5/fed. The results indicated that, the application of the larger amounts of N and P had a significant effect ($P<0.01$) plant higher, number of leaves, stem diameter, fodder and dry matter yields. In addition, this treatment increased the mineral content of soil and plant with a reduced of hydrocyanic acid (HCN) for fodder sorghum.

Keywords: Nitrogen, Phosphorus, Sorghum yield, Growth, Hydrocyanic, Mineral content.

Nitrogen (N) and phosphorous (P) are the essential elements required for plant growth in relatively large amounts. However, deficiencies of N and P are common in soils (Ashiono *et al.*, 2005). Soil nutrients become depleted due to leaching of N, fixation of P and removal by crops (Hosein *et al.*, 2007). In this respect, fertilizer application is one of the principle factors that materially set up the forage yield. An adequate supply of nutrients at each stage is essential for optimum growth and development of fodder yield (Cox *et al*., 1993).

N application is considered essential for growth and regrowth during growing season. Therefore, N plays an important role in quantity and quality of fodder crops (Hani *et al.*, 2006 and Almodares *et al.,* 2009) stated that the yield of fodder sorghum and protein content were increased by increasing the levels of N fertilizer. On the other hand, higher level of N application may increase hydrocyanic acid (HCN) contents of forage sorghum, ultimately poisoning animals (Aziz-Abdel and Abdel-Gwad, 2008).

Phosphorus is one of the major essential plant nutrients after N and is the second most deficient plant nutrient (Munir *et al*., 2004). The optimum rate of phosphorus application is important in improving yields of most crops (Cisar *et al.*, 1992). P application is important which directly contributes to the quality and quantity of fodder production. Application of P fertilizer gradually increased plant height, stem diameter, number of leaves per plant and fodder yield (Khalid *et al*., 2003). Moreover, Serrao *et al*. (2012) indicated that, the mean HCN, of sorghum varieties when grown under conditions most favorable for high HCN with high N and low P application.

In Egypt, newly reclaimed soils are alkaline and mostly calcareous in nature, high pH of calcareous soils has a negative effect on nutrient availability (Khattari and Tell, 1988). Mineral fertilizers play a vital role towards improving crop yields but one of the main constraints in achieving proven crop potential is imbalanced use of nutrients, particularly low use of P as compared to N. However, the optimum rate of P application is important in improving yields of most crops (Cisar *et al*., 1992). So, the fodder production grown in calcareous soils is low and quality is poor to meet the animal's nutritional requirement (Rashid and Iqbal, 2011).

In this respect, livestock is an important sector in new reclaimed areas of Egypt. From here, sorghum fodder (*Sorghum bicolor* L.) is one of the most widely adapted forage crops and grown extensively during summer season but when it's normal growth is constrained by imbalanced soil nutrients, hydrocyanic acid (HCN) content may develop to such an extent that the toxic level may reach lethal level when fed to animals (Fjell *et al*., 1991 and Amandeep, 2012). However, sorghum is still relished by animals due to succulence and palatability. Singh *et al.* (2008) indicated that the major factors limiting the sorghum fodder production are related to specific growth stages, insufficient fertilizer application and high contents of hydrocyanic acid. Also, limited research on impact levels of NP on sorghum hydrocyanic and information's is still provided in this regard relatively little. In addition, the insufficient and imbalanced use of fertilizers in Egypt is one of the major causes of crop yield reduction. So, the purpose of this research was to investigate the effect of NP fertilizer levels on growth and biochemical content of sorghum fodder grown in calcareous soil.

Material and Methods

A field experiment was carried out at the Maryout Research Station-Desert Research Center (DRC), between longitude 29°47′ and 11°18′ E and latitudes 31°00′ and 15°18′ N, during two successive seasons of 2010 and 2011 to study the effects of NP fertilizers on growth and biochemical content of sorghum fodder grown in calcareous soil. The soil is calcareous and sandy clay loamy texture. It is slightly acidic in reaction (pH 7.43). Also, the nutritional status of the soil is low to medium (Table 1). The level of soil organic matter content (OM) is low in the soil surface layers (1.02%) and the N, P and K contents are also low. The experiment was split plot design, with 10 treatments, each with three replicates (Table 2). The main plots were four levels of phosphorus (0, 20, 30 and 40 Kg P_2O_5/fed) and subplots were nitrogen rates (0, 80, 100 and 120 kg N/fed). N fertilizer was in the form of ammonium nitrate (33.5 % N) and applied in three equal splits. However, the applied of N was in early May (10 kg N/fed) as activing dose before sowing and then after the first and second cuttings of each season. P fertilizer was in the form of calcium superphosphate (15.5% P_2O_5) with mixed organic manure (10 m^3/fed) and applied annually before sowing. The seeds were sown on May 10, 2010 by line sowing method at the rate of 50 kg/fed, after completion of soil preparation and fertilizer application. Green sorghum fodder in each plots were harvested on 60^{th} day after sowing (1^{st} cutting) and then 40^{th} day after first and second cuttings, *i.e.,* 2^{nd} and 3^{rd} cuttings, respectively. The experiment was irrigated (flood) one time every week depending on growth stages of the crop to avoid water stress. At harvest in three cuttings, the plants were cut by hand just above the ground surface and the following parameters were taken-fodder yield (t/fed^{-1}), plant length (cm) No of leaves/plant and stem diameter (cm). Also, random plant samples from each plot were taken before harvest for analysis to hydrocyanic acid (HCN), N and P concentration, Plant samples were cleaned, dried at 60˚C, ground and digested in a mixture of sulfuric (H_2SO_4) and perchloric (HCl_4) and total of N and P in sorghum were determined according to AOAC (2000). Analyzed leaves and stem samples contents of HCN according to Gorz *et al*. (1977). In addition, three random soil samples from each plot were taken from the 0-30 cm depth after the harvest of all cuttings in the two seasons. Soil were mixed, air-dried and ground to pass a 2-mm sieve. Available of N, P and K in soil were determined according to Black *et al.* (1982).

TABLE 1. Some characters and nutritional status of investigated soil at (0-30) of soil depth.

Soil properties										
pH	**OM %**	**EC dS/m**	**$CaCO_3$ %**	**Sand %**	**Silt %**	**Clay %**	**Texture**	**Available macronutrients (mg/Kg^{-1})**		
								N	P	K
7.43	1.02	5.51	28.50	76.45	12.62	10.93	SCL	18.00	5.22	45.63

TABLE 2. Applied fertilizer treatments to sorghum plants through two study seasons of 2010 and 2011.

No.	Treatments	Fertilizer rate (Kg/fed)
1	Control	Without N and P
2	N_1 P_1	80 N + 20 P_2O_5.
3	N_2 P_1	100 N + 20 P_2O_5
4	N_3 P_1	120 N + 20 P_2O_5
5	N_1 P_2	80 N + 30 P_2O_5.
6	N_2 P_2	100 N + 30 P_2O_5
7	N_3 P_2	120 N + 30 P_2O_5
8	N_1 P_3	80 N + 40 P_2O_5
9	N_2 P_3	100 N + 40 P_2O_5
10	N_3 P_3	120 N + 40 P_2O_5

The obtained results in the two studied seasons were subjected to analysis of variance (ANOVA) to verify the differences among the effects of the applied treatments. The least significant difference (LSD) was recruited as to significant differences among treatment means at the *P* = <0.01 level of significance (Gomez and Gomez, 1984).

Results and Discussion

Growth parameters

The effect of different doses of N and P on growth parameters (*i.e.,* plant height, No. of leaf/plant and stem diameter) for three cutting in each season were presented in Table 3. The results revealed that plant height showed significant difference in all three cuttings at (P<0.01) by increasing N and P doses compared to control treatment. The tallest plant height was observed in N_3P_3 (120 kg/ N and 40 Kg/ P_2O_5 Fed.), having plant height 166.0, 152.86 and 140.08 cm, which was followed by the treatment N_3 P_2 (120 kg N and 30 Kg P_2O_5/ fed), having 161.96, 148.68 and 136.60 cm in three cutting, respectively. On the other hand, the shortest plant was (135.56 cm) observed in control treatment (without N and P). This increase might be due to the positive effect of N and P elements on plant growth that leads to progressive increase in internodes length and consequently plant height. Application of NP and their interaction significantly increased the number of leaves and significantly higher than the control (Table 3). A significant effect of N and P application in number of leaves was observed in 2^{nd} and 3^{rd} cuttings and the number of leaves was gradually increased with increasing of N and P levels.

Data regarding number of leaves in first have maximum number of leaves was obtained by applying N_3P_3 which was followed by N_3P_2 in the first , second and third cuttings, respectively. This may be due to increasing the N and P rates resulted in more leaves produced per plant with the highest mean values in most cases at 120 kg N and 40 Kg P_2O_5/fed. This shows that higher N and P rates enhanced the vegetative growth of the plant and increased the source capacity of the plants by the number of leaves produced per plant (Gungula *et al.,* 2005). This agrees with Aluko and Fischer (1987) who reported increased source capacity with increase in nitrogen levels. In addition to, stem diameter was increased significantly with increasing NP application and similar trends with plant height and number of leaves. The probable reason might be that optimum N and P supply played an essential role in plant growth and development. Similar responses were obtained by Afzal *et al.* (2012) sowed that increased of plant height and number of leaves per plant in sorghum was increased by increasing of N application under three cutting system. Also, Roy and Khandaker (2010) who observed that the significantly effect of P application in sorghum plant height was observed in three cutting. In addition to, high significantly were obtained regarding the effect of fertilization treatments on sorghum growth parameters in the second season compared to the first season. The obtained results are in agreement with those mentioned Amal *et al*. (2007) on sorghum growth and Abd El-Lattief (2011) on pearl millet growth parameters.

TABLE 3. Effect of NP levels on sorghum growth parameters through two sequence seasons.

Treatments	First season								
	Plant high (cm)			No. of leaf/plant			Stem diameter (cm)		
	First cut	Second cut	Third cut	First cut	Second cut	Third cut	First cut	Second cut	Third cut
Control	135.56	128.52	116.04	7.223	7.146	6.119	0.962	0.941	0.864
N_1P_1	150.96	139.43	128.33	7.913	7.822	7.734	1.021	1.016	1.008
N_2P_1	154.12	143.98	131.15	8.693	8.500	8.047	1.032	1.025	1.018
N_3P_1	160.82	146.62	135.45	8.802	8.686	8.158	1.043	1.036	1.027
N_1P_2	152.28	140.53	129.31	8.010	7.921	7.823	1.026	1.023	1.020
N_2P_2	155.59	144.59	133.63	9.161	8.864	8.495	1.039	1.033	1.024
N_3P_2	161.96	148.68	136.60	9.224	9.148	8.773	1.052	1.044	1.042
N_1P_3	153.49	141.82	130.66	8.107	8.034	7.918	1.031	1.026	1.026
N_2P_3	159.66	145.43	135.82	9.261	8.958	8.583	1.045	1.040	1.036
N_3P_3	166.00	152.86	140.08	9.331	9.244	8.908	1.064	1.056	1.053
Mean	155.04	143.25	131.71	8.573	8.432	8.056	1.031	1.024	1.012
P = <0.01									
All treatments	1.016	1.058	0.965	0.092	0.081	0.084	0.0032	0.0028	0.0060
N	0.838	0.982	0.831	0.081	0.071	0.076	0.0028	0.0025	0.0056
P	0.684	0.802	0.678	0.066	0.058	0.063	0.0023	0.0020	0.0046
Interaction	1.185	1.389	1.175	0.115	0.100	0.109	0.0039	0.0035	n.s.
	Second season								
Control	133.95	123.42	110.68	7.189	6.994	6.011	0.944	0.933	0.863
N_1P_1	152.35	140.91	130.19	8.036	7.880	7.776	1.024	1.018	1.010
N_2P_1	155.84	144.34	132.84	8.708	8.560	8.141	1.034	1.028	1.021
N_3P_1	155.39	148.83	136.33	8.911	8.701	8.176	1.047	1.039	1.026
N_1P_2	154.65	142.12	131.29	8.131	8.023	7.870	1.033	1.025	1.021
N_2P_2	158.66	145.45	134.89	9.204	8.952	8.528	1.044	1.037	1.035
N_3P_2	165.23	150.49	138.24	9.383	9.173	8.892	1.065	1.048	1.044
N_1P_3	160.79	143.21	132.89	8.234	8.112	7.966	1.042	1.029	1.028
N_2P_3	161.22	146.58	136.05	9.349	9.062	8.693	1.049	1.043	1.039
N_3P_3	169.55	154.19	142.18	9.490	9.331	9.022	1.072	1.061	1.055
Mean	156.76	143.95	132.56	8.663	8.479	8.108	1.035	1.026	1.014
P = <0.01									
All treatments	1.032	1.008	1.001	0.091	0.089	0.078	0.0030	0.0024	0.0028
N	0.914	0.915	0.884	0.080	0.081	0.071	0.0028	0.0020	0.0026
P	0.747	0.747	0.722	0.065	0.066	0.058	0.0023	0.0016	0.0021
Interaction	1.293	1.294	1.251	0.113	0.114	0.101	0.0039	0.0028	0.0036

Sorghum fodder yield

Data in Table 4 showed that the application of N and P and their interaction caused significant (P<0.01) differences among treatments in all three cuttings. Fodder yields of sorghum showed the highest response to increased rates of N and P fertilizers compared with the control treatment for all the cuttings in both seasons of the study. Maximum fodder yield were 16.80, 14.74 and 8.65 ton per fed by applying N3P3 which was followed by 16.40, 14.31 and 8.26 having NP applied at the N_3P_2 in the first, second and third cutting, respectively. This could be due to the application of

N and P on green fodder yield is resulted from that plant height, No of leaf/plant and stem diameter of plant increased due to increasing NP rates and this cause to increasing total green fodder yield. These results are an agreement with findings of Khalid *et al.* (2003) indicated that the increase in fodder yield with fertilizer application may be due to greater plant height, higher stem diameter, higher number of leaves per plant. Also the increases in the green fodder yield may be due to splitting N fertilizer dose in three equal portions may be attributed to minimize the loss of N by leaching besides saving suitable amount of N as plant need during the different stages of life which increased growth and yield.

TABLE 4. Effect of NP levels on fodder and dry matter yield through two sequence seasons.

Fodder yield (t/fed)								
Treatments	First season				Second season			
	1^{st} cut	2^{nd} cut	3^{rd} cut	Mean	1^{st} cut	2^{nd} cut	3^{rd} cut	Mean
Control	10.80	8.15	4.19	7.71	10.43	8.03	4.03	7.50
N_1P_1	14.23	12.04	6.56	10.94	14.46	12.26	6.65	11.12
N_2P_1	15.10	13.19	6.95	11.75	15.53	13.16	7.12	11.94
N_3P_1	16.05	14.08	7.36	12.50	16.19	14.09	7.50	12.60
N_1P_2	14.44	12.30	6.76	11.17	14.68	12.54	6.84	11.35
N_2P_2	15.86	13.86	7.43	12.39	16.09	13.90	7.76	12.58
N_3P_2	16.40	14.33	8.26	13.00	16.63	14.46	8.39	13.16
N_1P_3	14.64	12.41	7.00	11.35	14.88	12.84	7.02	11.58
N_2P_3	16.13	14.13	8.16	12.81	16.33	14.10	8.22	12.88
N_3P_3	16.60	14.54	8.48	13.21	16.86	14.68	8.80	13.45
Mean	15.02	12.90	7.12		15.21	13.01	7.23	
LSD 0.05								
All treatments	0.176	0.160	0.195		0.132	0.180	0.168	
N	0.156	0.148	0.178		0.110	0.145	0.154	
P	0.128	0.121	0.145		0.090	0.118	0.126	
Interaction	0.221	0.210	0.251		0.155	0.205	0.218	
Dry matter yield (t/fed)								
Control	1.51	1.03	0.60	1.05	1.28	1.00	0.59	0.96
N_1P_1	1.90	1.66	0.93	1.50	1.94	1.68	0.95	1.52
N_2P_1	2.24	1.89	1.04	1.73	2.31	1.90	1.06	1.76
N_3P_1	2.43	2.20	1.10	1.91	2.45	2.21	1.12	1.93
N_1P_2	1.96	1.74	0.98	1.56	2.01	1.75	1.01	1.59
N_2P_2	2.46	2.08	1.12	1.89	2.52	2.20	1.14	1.95
N_3P_2	2.60	2.29	1.23	2.04	2.67	2.30	1.24	2.07
N_1P_3	2.03	1.80	1.01	1.61	2.07	1.82	1.02	1.64
N_2P_3	2.56	2.26	1.22	2.01	2.61	2.30	1.24	2.05
N_3P_3	2.68	2.37	1.34	2.13	2.75	2.39	1.35	2.16
Mean	2.24	1.93	1.06		2.26	1.95	1.07	
LSD 0.05								
All treatments	0.060	0.073	0.049		0.050	0.055	0.033	
N	0.055	0.068	0.046		0.046	0.051	0.030	
P	0.046	0.055	0.038		0.038	0.042	0.025	
Interaction	0.079	0.096	0.065		0.065	0.073	0.042	

These results are in good accordance with those reported by (Sharief *et al.,* 2004 and Abd El-Lattief, 2011). In this direct, Abdullah *et al.* (2000) reported that total yield of green forage increased with the increasing level of P fertilizer. Similar results were obtained by Hassan (2003) on wheat, Hani *et al.* (2006) on maize, Mohammad *et al.* (2011) on barley, Ashiono *et al.* (2005), Amal *et al.* (2007), Amandeep (2012) and Hiroshi *et al.* (2013) on sorghum.

Dry matter yield

It could be seen from Table 4 that the results similar trends were obtained for dry matter production with fodder yield of sorghum in the two seasons. In this respect, it could be observed that the N and P fertilizer application and their interaction had significant effect on the dry matter yield which increased by increasing level of NP fertilizer in the first, second and third cuttings compared to the control. The dry matter yield were 2.68, 2.37 and 1.34 ton per fed by applying N_3P_3 which was followed by 2.60, 2.29 and 1.29 having N and P applied at the N_3P_2 in the first, second and third cuttings, respectively. Also, in second season, dry matter yield was highest significant compared to first season. These findings suggest that integrated use of N and P fertilizers has positive effect growth parameters and consequently the dry matter yield of sorghum fodder. Significant effect of N and P application on dry matter was also reported by Zahid and Bhatti (1994) indicated that the application of N increased dry matter. Also, Bhagwan *et al.* (1997) who indicated that dry matter yield increased with the increasing level of P fertilizer. In this respect, Mansoor *et al.* (2010) also demonstrated that NP application increased dry matter in sorghum.

Hydrocyanic acid (HCN)

The results in Table 5, revealed that, sorghum hydrocyanic acid content (on fresh basis) was higher in leaves than the stem and high in third cut compared to second and first cuttings, respectively. Also, higher total HCN contents in sorghum fodder with the application of highest rates of N and lowest rates of P fertilizer. In this respect, content of hydrocyanic acid (HCN) showed significant difference in all three cuttings at (P=0.01) by increasing N compared to control treatment in both seasons. A minimum HCN total contents were found in control treatment (401, 403 and 406 ppm) in first, second and third cutting, respectively, which was followed by the treatment (N_1P_3), having 393, 411 and 424 ppm, in three cutting, respectively. Whereas, maximum HCN total contents were observed in the (N_3P_1) treatment 496, 510 and 523 ppm in three cutting, respectively, which was followed by the (N_2P_1), having 482, 493 and 506 ppm, in three cutting, respectively. This may be due to application of high levels of N and low levels of P fertilizers (Aziz-Abdel and Abdel – Gwad (2008). In this respect, Wheeler *et al.* (1980) reported that the Hydrocyanic (HCN) potential (mean 0.04%) in forage sorghum was increased 28% by N fertilizer and reduced 34% by P application. Therefore, the P reduced the risks associated with HCN especially at an early growth stage, when such risks are most feared (Ahmad *et al.*, 2011). Also, McBee and Miller (1980) and Maryam Sarfraz *et al.* (2012) indicted that the safe limit of HCN in fresh fodder for livestock is 500 ppm. Hence, the treatments of (N_3P_1) and (N_2P_1) may produce unsuitable feed to the animals because of its higher content of HCN than the permissible limits. Based on these results, all fodder yields of sorghum are safe for livestock feeding except the previous treatments which high N and low P fertilizers.

TABLE 5. Effect of NP levels on sorghum hydrocyanic acid (HCN) content (on fresh basis) through two sequence seasons.

HCN (ppm)									
Treatments	**First season**								
	1 st cut			2 nd cut			3 rd cut		
	leaves	Stem	Total	leaves	Stem	Total	leaves	Stem	Total
Control	261	140	401	263	140	403	265	141	406
N_1P_1	309	166	476	316	166	482	315	166	481
N_2P_1	318	164	482	323	170	493	326	180	506
N_3P_1	321	174	496	330	179	510	335	188	523
N_1P_2	262	153	415	274	145	419	275	155	430
N_2P_2	274	152	426	277	156	433	283	162	445
N_3P_2	277	155	432	281	159	439	285	169	454
N_1P_3	264	148	412	267	148	416	273	152	425
N_2P_3	277	144	422	275	153	428	285	149	434
N_3P_3	279	146	425	276	155	432	283	156	439
Mean	285	154	439	288	157	445	292	162	454
LSD 0.05									
All treatments	1.316	1.984	2.106	2.129	1.775	3.092	1.866	2.151	2.729
N	1.207	1.809	1.965	1.895	1.613	2.764	1.641	1.662	2.051
P	0.985	1.477	1.606	1.547	1.317	2.257	1.340	1.357	1.675
Interaction	1.706	2.558	2.781	2.680	2.282	3.909	2.321	2.350	2.901
Second season									
Control	259	143	402	265	138	403	269	136	405
N_1P_1	308	161	469	307	138	473	316	163	479
N_2P_1	312	166	478	314	166	482	324	173	497
N_3P_1	317	173	491	323	169	503	332	188	519
N_1P_2	267	145	412	267	180	416	265	158	423
N_2P_2	277	147	424	276	149	430	276	163	439
N_3P_2	282	149	431	279	154	438	283	165	448
N_1P_3	270	139	409	270	159	413	271	150	421
N_2P_3	275	146	421	274	142	426	280	153	433
N_3P_3	278	147	425	276	152	432	281	157	438
Mean	284	152	436	285	156	442	290	161	450
LSD 0.05									
All treatments	1.865	1.876	2.754	1.703	1.524	2.326	1.859	1.630	2.556
N	1.656	1.749	2.486	1.490	1.371	2.110	1.563	1.434	2.275
P	1.352	1.428	2.030	1.216	1.120	1.723	1.276	1.171	1.859
Interaction	2.342	2.474	3.516	2.108	1.939	2.984	2.211	2.028	3.220

Mineral content of sorghum leaf

Leaf N

Data in Table 6 it is clear that the application of N had significant ($P<0.01$) differences among treatments in all three cuttings. Sorghum fodder showed the highest response to increased rates of N fertilizers than the control treatment for all cuttings in both seasons of the study. Maximum N percentage were 2.12, 1.98 and 1.84 by applying N_3P_3 which was followed by 2.10, 1.96 and 1.81 having NP applied at the N_3P_2 in the first, second and third cutting, respectively. The highest N content was obtained in the first cutting than the second and third cuttings. This may be due to the higher application of N fertilizer before and after sowing. Also, response of sorghum to N was high due to the importance of N fertilizer for fodder crops. In addition a high significant of interaction between P on N content was obtained due to the positive effect of P application on N. In this respect, response of sorghum to N fertilizer has been reported by EI-Wafa and EI-Hamd (2001). Moreover, N content in the second season was high significantly compared to the first season this may be due to high content of soil N in second season. Similar results were obtained by Hassan (2003), Ashiono *et al.* (2005) and Abou-Amer (2007).

TABLE 6. Effect of NP levels on leaf mineral content through two sequence seasons.

Leaf N (%)								
Treatments	**First season**				**Second season**			
	1^{st} cut	2^{nd} cut	3^{rd} cut	Mean	1^{st} cut	2^{nd} cut	3^{rd} cut	Mean
Control	1.52	1.41	1.23	1.39	1.45	1.38	1.19	1.34
N_1P_1	1.80	1.68	1.53	1.67	1.89	1.70	1.54	1.71
N_2P_1	1.92	1.84	1.60	1.79	1.96	1.86	1.63	1.82
N_3P_1	2.04	1.94	1.81	1.93	2.05	1.95	1.81	1.94
N_1P_2	1.83	1.70	1.54	1.69	1.91	1.73	1.56	1.73
N_2P_2	2.01	1.92	1.67	1.86	2.05	1.95	1.69	1.90
N_3P_2	2.10	1.96	1.81	1.96	2.14	1.97	1.83	1.98
N_1P_3	1.86	1.72	1.57	1.72	1.93	1.75	1.57	1.75
N_2P_3	2.06	1.94	1.70	1.90	2.09	1.97	1.73	1.93
N_3P_3	2.12	1.98	1.84	1.98	2.16	2.00	1.85	2.00
Mean	1.93	1.81	1.63		1.96	1.83	1.64	
$P = <0.01$								
All treatments	0.019	0.014	0.016		0.017	0.015	0.014	
N	0.014	0.013	0.015		0.016	0.014	0.012	
P	0.012	0.011	0.012		0.013	0.011	0.010	
Interaction	0.021	0.019	0.021		0.022	0.020	0.018	
Leaf P (%)								
Control	0.155	0.138	0.120	0.138	0.154	0.135	0.118	0.136
N_1P_1	0.186	0.179	0.163	0.176	0.188	0.180	0.165	0.178
N_2P_1	0.191	0.181	0.165	0.179	0.194	0.182	0.166	0.181
N_3P_1	0.192	0.184	0.168	0.181	0.195	0.186	0.170	0.184
N_1P_2	0.194	0.192	0.184	0.190	0.198	0.194	0.186	0.193
N_2P_2	0.203	0.198	0.200	0.200	0.204	0.198	0.203	0.202
N_3P_2	0.212	0.211	0.208	0.210	0.213	0.213	0.210	0.212
N_1P_3	0.206	0.198	0.198	0.201	0.209	0.201	0.199	0.203
N_2P_3	0.210	0.207	0.205	0.207	0.211	0.209	0.206	0.209
N_3P_3	0.215	0.213	0.210	0.213	0.216	0.214	0.211	0.214
Mean	0.196	0.190	0.182		0.198	0.191	0.183	
$P = <0.01$								
All treatments	0.0013	0.0010	0.0011		0.0012	0.0015	0.0014	
N	0.0012	0.0009	0.0010		0.0011	0.0013	0.0012	
P	0.0010	0.0007	0.0008		0.0009	0.0011	0.0010	
Interaction	0.0017	0.0013	0.0014		0.0015	0.0019	0.0018	

Leaf P

From the results in a Table 6 indicated that the application of P had significant ($P<0.01$) on leaf P content in two seasons of study. Also, P percentage was increase by increasing of P application rates. The highest P percentage were 0.215, 0.213 and 0.210 by N_3P_3 treatment which was followed by 0.212, 0.211 and 0.208 having applied at the N_3P_2 in the first, second and third cutting, respectively. P percentage was highest in the first cutting compared to the second and third cuttings. This may be due to the increased of soil P content and response of sorghum plants grown in calcareous soil. Also, the application of N fertilizer was high significant to increase of leaf P percentage. In addition to, leaf P in the second season was high significantly than the first season. This results is in agreement with the observation of (Buah *et al.,* 2000, Chaudhry *et al.,* 2003, Rehman *et al.,* 2007 and Rashid & Iqbal, 2011).

Soil mineral content

Soil N

The results in Table 7 and it was observes that N (mg/Kg^{-1}) application to the soil highly increased N content in soil than the control. Also, increase of N content in soil was increasing by N application. Maximum soil N content were 32.65, 28.25 and 26.02 by applying N_3P_3 which was followed by 29.74, 27.75 and 25.16 having by N_3P_2 in the first, second and third cutting, respectively. This may be due to the application of N fertilizer and organic manure to soil and importance of N fertilizer to calcareous soil. However, soil N was declined gradually as a result of plant uptake of N throughout the growing season and increased of sorghum growth parameters in the first cutting than the second and third cuttings. Also, application of P fertilizer was positive effect on soil N content. In addition to, similar trends were observed in the second season and soil N was more pronounced as compared to the first season. Similar results are in agreement with (Hassan, 2003 and Abou-Amer, 2007).

Soil P

Data in Table 7 showed that P soil content (mg/Kg^{-1}) was higher significant by application of P fertilizer compared to the control treatment. P soil content was increased with increasing P application. This may be due to the low P content of calcareous soil. The highest P soil content were 9.04, 8.39 and 7.50 by N_3P_3 treatment which was followed by 8.25, 8.04 and 7.38 having by N_3P_2 in the first, second and third cutting, respectively. This may be due to the absorption of plant to available P soil and regrowth of sorghum (Berry and Miller, 1989). However, the highest rates of P in calcareous soil enhance P availability, because the lime in calcareous soil reacts with soil solution P to form a strong calcium phosphate bond at the surface of the lime. Therefore, high P fertilizer rates are required for crops grown in calcareous soil, with increasing rates needed as lime content in these soils increases (Bryan and Jason, 2005). Also, the positive effect of N applications was increased available P soil increased. In this respect, Gahoonia *et al.* (1992), studying soil P release in the rhizosphere of ryegrass, found that, under NH4-N nutrition, soil P depletion in the vicinity of roots was also correlated with the pH decrease in a calcareous. Also, more roots of the

NH4-supplied plant was the result of more growth of root and shoot caused by higher P uptake. It is, therefore, the increased P uptake of NH4-N supplied plants was brought about by an increased P influx per unit of root length rather than by changes in root growth (Christa *et al.*, 1994). In addition to, soil P content in the second season was higher than the first season may be due to increase in content of soil P in successive seasons.

TABLE 7. Effect of NP levels on soil N and P mineral content through two sequence seasons.

Treatments	First season				Second season			
	1st cut	2nd cut	3rd cut	Mean	1st cut	2nd cut	3rd cut	Mean
Soil N (mg/kg^{-1})								
Control	15.56	13.23	11.28	13.36	14.19	12.86	10.46	12.50
N_1P_1	21.52	20.34	18.03	19.96	22.35	21.15	17.85	20.45
N_2P_1	23.18	22.19	20.64	22.00	23.93	22.68	20.19	22.26
N_3P_1	28.31	26.54	24.30	26.38	28.86	27.20	24.10	26.72
N_1P_2	22.48	20.91	18.54	20.64	23.08	21.78	18.96	21.27
N_2P_2	24.53	23.40	22.23	23.39	25.73	23.52	22.12	23.79
N_3P_2	29.74	27.75	25.16	27.55	30.38	28.78	26.23	28.46
N_1P_3	23.38	21.46	19.01	21.28	23.96	22.68	20.04	22.22
N_2P_3	25.86	24.30	22.61	24.26	26.63	23.95	23.20	24.59
N_3P_3	32.65	28.25	26.02	28.97	33.34	29.53	28.35	30.41
Mean	24.72	22.84	20.78		25.24	23.41	21.15	
LSD 0.05								
All treatments	0.764	0.312	0.334		0.692	0.390	0.350	0.764
N	0.713	0.278	0.285		0.647	0.358	0.338	0.713
P	0.582	0.227	0.232		0.528	0.292	0.276	0.582
Interaction	1.008	0.393	0.401		0.915	0.506	0.478	1.008
Soil P (mg/kg^{-1})								
Control	4.38	3.93	2.92	3.74	3.91	3.10	2.70	3.24
N_1P_1	6.31	5.96	5.14	5.80	6.52	6.25	5.21	5.99
N_2P_1	6.47	6.15	5.66	6.09	6.64	6.29	5.35	6.09
N_3P_1	6.65	6.26	5.93	6.28	6.80	6.38	6.06	6.41
N_1P_2	7.84	7.56	7.09	7.50	7.96	7.58	7.21	7.58
N_2P_2	8.05	7.83	7.24	7.70	8.08	7.90	7.25	7.74
N_3P_2	8.28	8.04	7.38	7.90	8.47	8.32	7.53	8.11
N_1P_3	8.20	7.89	7.32	7.80	8.14	7.92	7.32	7.80
N_2P_3	8.18	7.96	7.41	7.85	8.35	8.00	7.40	7.92
N_3P_3	9.04	8.39	7.50	8.31	9.08	8.73	7.69	8.50
Mean	7.34	7.00	6.36		7.40	7.05	6.37	
LSD 0.05								
All treatments	0.076	0.076	0.079		0.092	0.085	0.081	
N	0.061	0.071	0.074		0.085	0.078	0.075	
P	0.049	0.058	0.060		0.069	0.064	0.061	
Interaction	0.086	0.100	0.104		0.120	0.110	0.106	

Conclusion

The treatment of N_3P_3 (120 kg/ N and 40 Kg/ P_2O^5 Fed) was considered the best treatment within the range of the treatments used in this study. However, it should be noted that the four treatments (N_2P_2, N_2P3, N_3P_2 and N_3P_3) gave the highest yield of fodder and dry matter. Fodder produced was also safe for animal feeding due to its low content of hydrocyanic acid (HCN) which was less than 500 ppm a considered toxicity level to animals. The recommended dose however depends on the fertility status of the soil used and its content of such elements

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تأثير التسميد النيتروجينى والفوسفاتى على النمو والمحتوى البيوكيمائى لسورجم العلف النامى فى الأراضى الجيرية

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أجريت تجربة حقلية في منطقة مريوط خلال عامى 2010 و 2011 لدراسة تأثير إضافة النيتروجين والفوسفور على النمو، محصول العلف ، حمض الهيدروسيانك والمحتوى المعدنى لنبات السورجم وشملت المعاملات لنباتات سورجم العلف اضافة النيتروجين عند أربع معدلات وهى صفر ،80، 100، 120 كجم نيتروجين/فدان و كذلك إضافة الفوسفور عند أربع معدلات وهى صفر ،20، 30 ، 40 كجم P_2O_5/ فدان. تمت إضافة معاملات الفوسفورعلى دفعة واحدة مع السماد العضوى فى اوائل شهر مايو.بينما تمت إضافة النيتروجين على أربع جرعات . الأولى كانت مع السماد العضوى كجرعة منشطة ثم اضيفت ثلاث جرعات متساوية بعد كل حشة على مدار الموسم . تمت اضافة السماد البوتاسى والعضوى لجميع المعاملات بمعدلات 50 كجم K_2O والسماد العضوى بمعدل 10 م^3 / فدان.

وقد أظهرت النتائج تأثير معنوى عند استخدام اعلى معدلات اضافة للنيتروجين والفوسفور (120 كجم نتروجين و40 كجم P_2O_5 /فدان) حيث أدت هذه المعاملة الى زيادة معنوية فى محصول العلف الآخضرومحصول المادة الجافة والمحتوى المعدنى للتربة والنبات مع انخفاض معنوى فى محتوى السورجم من حمض الهيدروسيانك السام.

مع ذلك ، تجدر الاشارة الى أن المعاملات الأربعة (N_2P_2, N_2P_3, N_3P_2 and N_3P_3) أعطت أعلى محصول من العلف والمادة الجافة كما أنها آمنة لتغذية الحيوانات عليها نظرا لانخفاض محتواها من الهيدروسيانك (اقل من مستوى السمية وهو 500 مجم). مع إعتبار أن المعاملة الاخيرة (N_3P_3) هى الأفضل وذلك فى حدود المعاملات المستخدمة فى هذه الدراسة . مع الأخذ فى الاعتبار أن معدل التسميد الأمثل يعتمد على حالة خصوبة التربة المستخدمة ومحتواها من هذه العناصر عند تطبيق هذه النتائج.