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MUTUAL EFFECT OF SOME MACRONUTRIENTS ON GUAR PLANTS GROWN IN CALCAREOUS SOIL

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ABSTRACT

Two field experiments were carried out during the growing seasons of 2001 and 2002in calcareous soil of Maryout Research Station (Desert Research Center) to study the effect of mineral fertilization N , P and K individually and their combinations on the yield , (straw , pods and seed) , plant components and chemical constituents of guar plants. Nitrogen was added at the rates of 0 , 20 and 40 kg N / fed ,also phosphorus and potassium were added at three rates (0 , 32 and 64 kg P_2O_5 / fed) and (0 , 24 and 48 kg K_2O / fed), respectively .

Results showed significant increases of guar straw, pods, seeds yields and N content with increasing N application. Similar trends were found for P and K fertilization, where they increased significantly guar yield as well as the content of N in the studied guar seeds.

The combined treatment (40 kg N + 64 kg P_2O_5 + 48 kg K_2O /fed) gave the highest yields of straw, pods, seeds and guaran % (29.1 and 30.2 %) in the both studied seasons.

INTRODUCTION

Guar (cyamopsis tetragonoloba, L. Tuba), Family: leguminosae, was originally grown in India since ancient times for food and feed. Recently it grown in Pakistan, U.S.A., Australia, Brazil and South Africa. Guar is one of the new important crops, because it contains crude material that inters in many industries; textile manufacture (first industry of Egypt) ; finishing of silks , paper manufacture, printing presses as solidifier , food manufacture as cheese ,cream and ice-cream, etc., preparation of water colours,classification of liquors and medicine industries . Besides, it is used as a fodder by animals and as a vegetable by human (Thakur, 1975).

The success of this plant as an important source of mucilage beside other uses and the increasing demand has naturally attracted the attention to cultivate the plant in Egypt.

Fertilization is one of the most important factors affecting the yield, yield components and chemical composition of guar plants (mucilage in guar seeds).

MATERIALS AND METODS

Two field experiments were carried out in calcareous soil of Maryout Research Station. Some of the relevant physical and chemical properties of the soil and irrigation water are given in tables (1) and (2). The analysis was undertaken according to the standard methods described by Chapman and Pratte (1961) .The experiment was carried out through two seasons (2001 and 2002) and plants were grown in the first of May in each season.

The treatments were arranged in split split block design with three replicates (27 treatments) and the area of each plot was 2 x 3 m (1/700fed) and irrigation was with surface irrigation method. In the two seasons, three treatments of nitrogen fertilizer, as ammonium nitrate (33.5%) were applied at the rate of 0, 20 and 40 kg/ fed, through two doses. The 1st dose was as 1/4 of the quantity of each rate added during cultivation and after 30 days from the cultivation. The 2nd dose was added as the rest quantity of each rate.

Also, three rates of superphosphate (15.5% P_2O_5), i.e., 0, 32, and 64 kg P_2O_5 /fed were added before cultivation, while pctassium sulphate (48% K_2O) rates, i.e., 0, 24 and 48 kg /fed were added through two splits as mentioned with nitrogen and in the same time of adding N fertilizers.

All plots received a mixture of Fe, Mn and Zn in the EDTA form ratios of 1:1: 1.5 respectively, 0.5 g/l of the mixture of the previous micronutrients with 1 mg Cu/l as EDTA form were added foliarly in two times after 30 and 45 days from cultivation.

Table (1): Some physical and chemical characteristics of the studied soils

(A) Particle size distribution of soil

Coarse sand%	Fine sand%	Silt %	Clay %	textural class
5.3	41.5	35.2	18.0	Sandy clay loam

(B) Chemical properties of soil.

*EC dS/m	**pH	CEC meq/100 gm soil	O.M %	$CaCO_3$ %	Soluble cations and anions of soil (meq/L)								Available Macronutrients mg/ 100 g soil		
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	N	P	K
3.94	7.7	18.1	0.64	28.0	14.8	13.2	10	1.10	-	6.0	21.0	12.1	1.33	0.87	10.21

* In soil paste extract. ** In soil (1: 2.5) soil: water suspension

Table (2) chemical characteristics of irrigation water .

PH	EC dS/m	Cations (me/L)				Anions (meq/L)			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
8.30	3.25	9.0	14.0	8.36	0.64	-	6.60	18.0	7.40

RESULTS AND DISCUSSION

Effect of mineral fertilizers (N, P and K) and their interactions on the yield of guar plants.

Data in Tables (3-5) showed that guar pods ,straw and seeds yields increased significantly with increasing N,P and K fertilizers individually or in combinations .

Increasing application of N increased highly significantly the yields of straw, pods and seeds by 24.6 % to 43.1 % (straw) ,16.1% to 32.6% (pods) and 26.9% to 28% (seeds) at the rate of application 20 and 40 kg N/fed , respectively in the 1st season . The corresponding at the 2nd season reached 23.7% to 37.4% (straw), 22.2% to 37.7% (pods) and 28.3% to 53.2 % (seeds) compared with control treatment .The increases of guar organs yield due to the addition of N may be attributed to the beneficial effect of N on protein formation, and as it is known that N is an integral part of chlorophyll which is the primary absorber of light energy needed for photosynthesis. Also, the increased of yield may be due to the

increase in the surface area of leaves induced by N application, (Russel, 1973).

Finally, this effect is pronounced since the experimental soil is impoverished in most nutritive elements and N is one of them in this respect many investigators found that application of N increased the yield of guar plants , Singh and Singh (1989a) , Ghanem (1990) , Hussain (1990), Baboo and Rana (1995) and Mahamoud et al ., (1996).

Table (3): Effect of N, P and K treatments and their interactions on the dry matter yield of guar straw (kg/fed.) (Leaves + stems).

Treatments		Season 2001				Season 2002			
		K0	K1	K2	N means	K0	K1	K2	N means
N0	P0	1255	1372	1466	1612	1466	1592	1748	1788
	P1	1476	1646	1836		1614	1798	1995	
	P2	1630	1840	1991		1790	1954	2133	
N1	P0	1522	1643	1835	2008	1739	1883	2049	2211
	P1	1932	2020	2303		2138	2249	2398	
	P2	2036	2250	2534		2256	2463	2723	
N2	P0	1774	1955	2069	2306	1994	2128	2249	2457
	P1	2204	2342	2455		2310	2446	2549	
	P2	2464	2696	2797		2620	2836	2985	
K means		1810	1974	2143		1992	2150	2314	
P means		1655	2024	2249		1872	2166	2418	

Treatment	LSD				Interaction	LSD			
	2001		2002			2001		2002	
	0.05	0.01	0.05	0.01		0.05	0.01	0.05	0.01
N	5	9	8	14	N x P	7	10	5	8
P	4	6	3	4	N x K	8	10	9	12
K	4	6	5	7	P x K	8	10	9	8
N x P x K (0.05)	13		15		N x P x K (0.01)	18		20	

With respect of P fertilizers effect on the yield of guar organs, data in Table (3-5) showed that increasing P application increased significantly the yield of the studied parameters. Where the highest increase of the straw, pod and seed yields were found with application of 64 kg P_2O_5 / fed and reached 35.9& 29.2; 41.4& 39.8 &52.6 and 61.5% in1st and 2nd seasons, respectively compared with the control treatment. The favorable effect of P on the yield may be attributed to the deficiency of available P in the soil (0.87 mg P /100gm soil). Also, guar is legume crop and the effect of P is known to activate microbial population responsible for nodulation. But, efficient nodulation owing to P application might have enhanced N fixation to be utilized by plants and ultimately increased the protein content. Further more P also helps develop more extensive root-system, which might have helped to absorbed more water and nutrients from deeper soil layers for higher photosynthetic activity and translocation of photosynthates to the sink or the sites of their requirement , consequently increased all the parameters studied (Bhadoria ,et al. 1997) . In this respect many investigators found that increasing application of P increased the yield of guar plants , Bhadoria ,et al. (1997) ,Kan and Gurjar (1997), Solanki ,et al.(1998) and Kumawat and Khangarot (2002).

Table (4): Effect of N, P and K treatments and their interactions on the dry matter yield of guar pods (kg/fed.).

Treatments		Season 2001				Season 2002			
		K0	K1	K2	N means	K0	K1	K2	N means
N0	P0	629	757	900	949	655	767	889	946
	P1	848	939	1056		826	923	1040	
	P2	1002	1166	1247		1031	1152	1234	
N1	P0	781	921	1100	1102	830	992	1181	1156
	P1	943	1103	1241		983	1162	1265	
	P2	1123	1281	1420		1180	1343	1472	
N2	P0	911	1075	1190	1258	935	1120	1224	1303
	P1	1114	1255	1336		1140	1290	1410	
	P2	1343	1506	1591		1354	1563	1689	
K means		966	1111	1231		993	1146	1267	
P means		918	1093	1298		955	1116	1335	

Treatment	LSD 2001		LSD 2002		Interaction	LSD 2001		LSD 2002	
	0.05	0.01	0.05	0.01		0.05	0.01	0.05	0.01
N	5	9	4	6	N x P	7	10	4	6
P	4	6	2	3	N x K	6	8	4	6
K	3	4	3	3	P x K	6	8	4	6
N x P x K (0.05)	9		8		N x P x K (0.01)	13		10	

Table (5): Effect of N, P and K treatments and their interactions on the dry matter yield of guar seed (kg/fed.).

Treatments		Season 2001				Season 2002			
		K0	K1	K2	N means	K0	K1	K2	N
N0	P0	356	401	443	465	369	422	459	498
	P1	405	473	524		430	494	559	
	P2	476	525	586		517	583	647	
N1	P0	376	457	552	590	398	487	546	639
	P1	496	552	692		540	615	702	
	P2	665	715	804		720	845	895	
N2	P0	441	532	621	595	471	576	666	763
	P1	615	677	767		693	766	805	
	P2	783	850	971		949	914	1026	
K means		513	576	662		565	634	701	
P means		464	578	708		488	623	788	

Treatment	LSD 2001		LSD 2002		Interaction	LSD 2001		LSD 2002	
	0.05	0.01	0.05	0.01		0.05	0.01	0.05	0.01
N	4	7	3	6	N x P	5	7	4	6
P	3	4	2	3	N x K	4	5	4	5
K	2	3	2	3	P x K	4	5	4	5
N x P x K (0.05)	7		6		N x P x K (0.01)	9		9	

Respecting the effect of K on the yield of guar plants, data showed that, increasing application of K elevated significantly and progressively the yield of all studied organs of guar plants. The highest increase of straw, pods and seed yields were associated with the addition of 48 kg K_2O/fed. These increases reached 18.4 and 16.2 (straw) ; 27.4 and 27.5 (pods) and 29.0

and 24.1% (seeds) in 1 st and 2nd seasons, respectively compared to control . The favorable effect of K may be attributed to the low content of K in soil (10.21 mg K / 100gm soil) and also K promotes the role of the translocation of the newly synthesized photosynthates and the mobilization of the stored materials to seeds. Also , it is known that K plays an important role in vital processes such as enzyme activation , osmotic regulation , production of high (ATP) energy and plant translocation ,of sugars ,Jules et al (1986). These results are in agreement with those observed by Razin (1978), Haag, et al (1990) and Omar, et al (1993).

The interactions effect of (NXP), (NXK), (PXK) and (NXPXK) increased significantly the yield of straw, pod and seed yields of guar plants. It is noticed that the highest yield of straw, pods and seeds were 2797, 1591 and 971 kg /fed respectively and were associated with the addition of (40 kg N+ 64 kg P_2O_5 + 48 kg K_2O)/fed in1st season. The corresponding values at the 2nd season were 2985, 1689 and 1026 kg/ fed. This effect indicates the importance of mineral fertilization by NPK on increasing the yield of guar plants. The results are in a good line with those found by Faraag and Abd El-Lateef (1996) ,Bhunia (1996) ,Dahiya et al .(1996) and Anurag saxena et al .(2003).

Effect of mineral fertilizers (N, P and K) and their interactions on N content of guar seeds:

Data in Table (6) indicated that, N application had highly significant effect on N content of guar seeds in both studied seasons.

However, the highest values of N content of guar seeds were associated with the addition of 40 kg N /fed treatment in 1st and 2nd seasons. Similar results were obtained by Hussain (1990), Singh and Singh (1990) and Baboo and Rana (1995).

Concerning the effect of P fertilization on N content of guar seeds , data showed that the highest percentage increase of N content were 67.3 and 83.5 % by the addition high level of P (64 kg P_2O_5 / fed) in both studied seasons , respectively compared to control . These results are in agreement with finding of Gill (1979) and Meawad , et al . (1991).

With respect of K fertilization , data revealed that increasing K level from 24 to 48 K_2O / fed increased significantly N content of guar seeds in the two studied seasons . Likewise , the highest percentage increases were 37.4 and 31.9% for N content of guar seeds in 1st and 2nd seasons, respectively compared to control . The positive effect of K on N content may be attributed to the role of K in forming protein in cells (Kamh et al., 1991) .

Regarding to the interacion effect , data showed that the double and triple interactions affected significantly the N content of guar seeds .

Effect of mineral fertilizers (N,Pand K) on guaran content:

The guaran concentration in guar seeds is showen in Table (7) .Guaran % increased by the using of combined fertilizers ,i.e,N ,P and K compared with control . The best treatment for producing the highest guaran (29.1 and 30.2 %) was associater with addition of N2P2K2 ,i.e 40 kg N+ 64 kg P_2O_5 +48 kg K_2O/ fed in both seaseons repectively .It is also important to mention that the guaran content (%) was ranged between 24.7% and 29.1 % in1st season .While being 25.3% and 30.2%in the 2nd season.

This increase in guaran concentration could be assigned to the increase of N,K uptake and the beneficial effect of P application on gum production as has been described by Singh and Singh (1989-a). These results are in harmony with those found Razin (1978), Meawad et al ., (1991) , Baboo and Rana (1995) and Bhadoria et al.,(1997) .

Table (6): Effect of N, P and K treatments and their interactions on N content (kg/fed.) of guar seeds.

Treatments		Season 2001				Season 2002			
		K0	K1	K2	N means	K0	K1	K2	N means
N0	P0	12.19	14.14	16.20		12.80	15.03	16.76	
	P1	14.24	17.11	19.54	17.31	15.77	18.71	21.63	19.12
	P2	18.03	20.60	23.72		20.72	23.65	27.00	
N1	P0	13.47	16.76	20.65		14.29	17.79	20.85	
	P1	17.89	20.43	26.38	22.56	20.42	23.85	28.22	25.47
	P2	25.75	28.60	33.14		29.39	35.49	38.94	
N2	P0	16.40	20.39	24.45		17.47	22.06	26.96	
	P1	23.07	26.11	30.90	27.81	26.96	31.04	34..22	31.60
	P2	31.46	35.37	42.12		39.77	39.75	46.16	
K means		19.17	22.17	26.34		21.96	25.26	28.97	
P means		17.18	21.74	28.75		18.22	24.53	33.43	

Treatment	LSD 2001		LSD 2002		Interaction	LSD 2001		LSD 2002	
	0.05	0.01	0.05	0.01		0.05	0.01	0.05	0.01
N	*0.20*	*0.34*	*0.18*	*0.30*	N x P	*0.35*	*0.49*	*0.24*	*0.33*
P	*0.20*	*0.28*	*0.14*	*0.19*	N x K	*0.26*	*0.35*	*0.18*	*0.24*
K	*0.15*	*0.20*	*0.11*	*0.14*	P x K	*0.26*	*0.35*	*0.18*	*0.24*
N x P x K (0.05)	*0.46*		*0.61*		N x P x K (0.01)	*0.32*		*0.42*	

Table (7): Effect of N, P, K, fertilizers on guaran concentration (%) in guar seeds during 2001and2002 season.

Treatments	N0K0P0	N0K2P1	N0K0P2	N0K1P2	N1K0P1	N1K1P1	N1K1P2	N1K2P1	N1K2P2	N2K1P0	N2K0P1	N2K0P2	N2K1P1	N2K2P1	N2K1P2	N2K2P2
Guran%	Season(1)															
	24.7	26.2	27	26.9	26.6	27.4	27.7	27.5	28.1	26.3	26.9	27.3	27.6	27.7	28.2	29.1
	Season(2)															
	25.3	26.8	27.6	27.4	27.2	27.9	28.2	28.0	28.6	27.0	27.5	28.0	28.3	28.6	29.0	30.2

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التاثير المتبادل لبعض المغذيات الكبرى على نباتات الجوار النامية في أرض جيرية

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أجريت تجربتان حقليتان خلال موسمى (٢٠٠١- ٢٠٠٢) فى أرض جيرية بمحطة بحوث مريوط (التابعة لمركز بحوث الصحراء) لدراسة تأثير التسميد المعدنى بالنتروجين والفوسفور والبوتاسيوم منفردين وتفاعلاتهم على المحصول (القش والقرون والبذور) ومكوناتة والتركيب الكيميائى لنباتات الجوار .أضيف السماد النتروجينى بثلاثة معدلات هى (صفر ، ٢٠،٤٠كجم ن / فدان) والفوسفور والبوتاسيوم أيضا بثلاثة معدلات هى (صفر ، ٣٢، ٦٤كجم فو٢أ٥/ فدان) و (صفر ، ٢٤ ، ٤٨ كجم بو٢أ٥/ فدان) على الترتيب .

- أظهرت النتائج زيادة معنوية فى محصول القش والقرون والبذور والمحتوى من النتروجين لنباتات الجوار مع زيادة الاضافة من السماد النتروجينى.وحدث أيضا زيادة معنوية فى المحصول و المحتوى من النتروجين فى بذور الجوار مع التسميد الفسفورى والبوتاسى .
- وكانت أحسن معاملة أعطت أعلى محصول من القش والقرون والبذور هى (٤٠ كجم ن+٦٤كجم فو٢أ٥ +٤٨كجم بو٢أ٥ / فدان) وأعطت أيضا أعلى نسبة من الجواران (٢٩,١و٣٠,٢%) فى كلا الموسمين على الترتيب .