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Influence of Inoculation with Some *Bradyrhizobium* Strains on Yield Attributes, Seed Proximate Composition and Minerals Content of Guar (*Cyamopsis Teteragonolopa L.*) Grown in Sudan

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Abstract: *Bradyrhizobium* strains: ENRRI 16A, ENRRI 16C (Local) and strains TAL 169 and TAL 1371 (Introduced) were used to inoculate two guar cultivars namely, HFG-75 and Local, in split plot design with four replications in field experiment at two locations (Bara and Elsemeih, North Kordofan State- Sudan). The objective of the experiment was to study the effect of inoculation on yield attributes, proximate composition and minerals content of guar. The four *Bradyrhizobium* strain*s* used, significantly ($p \leq 0.05$) increased number of fruiting branches/plant, insignificantly improved grain yield (g) and yield (kg/ha), but exerted no effect on the 100-seed weight at the two locations. Also, inoculation significantly ($p \leq 0.05$) enhanced the plant height and number of pods/plant at Elsemeih and Bara, respectively. Treatment with *Bradyrhizobium* strain*s* insignificantly ($p \leq 0.05$) affected moisture, ash and oil contents of the tested guar cultivars at Bara location. At Elsemeih site, moisture and oil (except for TAL 1371) followed the same trend. Exceptionally, the ash content was significantly increased. Seed protein content of the two tested guar cultivars at Elsemeih showed significant improvement conversely, to that at Bara site. As a result of inoculation with *Bradyrhizobium* strains, only insignificant increases in phosphorus, calcium and magnesium contents of guar seeds were observed at both Bara and Elsemeih sites. Strains ENRRI 16C, TAL 169 and TAL 1371 caused significant ($p \leq 0.05$) increase in the mean potassium content at Bara location. On the other hand, only the local strain ENRRI 16A significantly ($p \leq 0.05$) elevated potassium content. The mean sodium content of guar seeds was significantly ($p \leq 0.05$) increased due to inoculation with local ENRRI 16A and the introduced TAL 1371 *Bradyrhizobium* strains at Bara site, on the contrary, treatment with *Bradyrhizobium* failed to change sodium content at Elsemeih site.

Key word: *Bradyrhizobium*, inoculation, guar, proximate composition, minerals content

INTRODUCTION

Guar (*Cyamopsis tetragonoloba* .L), member of the family fabaeace, is a drought – tolerant legume requiring 400-500 mm annual rainfall Yousif, (1984). The legume showed the best growth in the United States with 900 mm Francois *et al.,* (1990), performed well in areas with 400-900 mm of annual rainfall Anon and Esser, (1975) and can be cultivated in regions with 300-500 mm annual rainfall Mukhtar,(1981).

Guar has been well grown in wide range of soils. The most excellent performance is on the fertile medium to light sandy loam soil with pH values of 7.5 to 8 Francois *et al.,* (1990). Guar grows excellently on well drained soils with light to medium texture, pH value of 7.5-8 and temperature of 21 – 30 ^{0}C at planting time (Chapman and Pratt, 1961; Tyagi *et al.,* 1982). Soil salinity significantly decreased nodulation, pod formation and yield of guar Elsayed, (1994).

Guar is greatly valued because of its gum, which is characterized with high level of viscosity, hence used economically in mining, petroleum, tobacco, textile, cosmetics, pharmaceuticals and food industries.

Inoculation of guar with *Rhizobium* enhanced seed yield Singh (1989), number of nodules, nodules fresh weight, plant dry weight, nitrogen fixation and total nitrogen content (Mand *et al.,* 1991; Suman-Mor *et al.,* 1995). Although inoculation with different strains of *Bradyrhizobium* significantly improved shoot fresh and dry weight, number of pods and nodules, seed quality and yield (Elshiekh, 1993; Ibrahim, 1997). Also inoculation of guar with *Rhizobium* on sandy loam soil elevated seed yield, seed gum and protein content Brokwell *et al.,* (1995).

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In North Kordofan State – Sudan, no trials have yet been carried out to evaluate the response of guar to inoculation and its effect on seed quality. The present study was conduced to investigate the effect of inoculation with four bradyrhizobium strains on yield attributes, seed proximate composition and minerals content of two guar cultivars grown at two deferent locations in North Kordofan State – Sudan.

MATERIAL AND METHODS

Cultivars: Seeds of two guar cultivars (Local and HFG-75) supplied by the ministry of Agricultural and Forestry, Sudan.

Inocolum: Two locally isolated strains of *Bradyrhizobium spp*. (ENRRI 16A and ENRRI 16C) provided by Biofertilizers Department, Environment and natural Resources Institute, National Centre for Research, Khartoum, Sudan, in addition to another two introduced strains of *Bradyrhizobium spp*. (TAL 169 and TAL 1371) offered by NifTAL Project, Paia, Hawaii, USA. The strains were maintained at 4 °C on yeast extract mannitol agar (YEMA) slopes.

Field Experiment:

The field experiment was conducted during 2006/07 cropping season in North Kordofan State, Sudan at two locations:

Bara, 57 km North Elobeid city, longitude 30^0 42' 24, latitude 13^0 42' 78, soil with 83% sand, 3.0% silt, 14% clay, 0.02% N, 0.04% P, 0.6% O.C, 6.5 pH value, and 1.54, 8.1, 1.25 and 0.25 meq/l K, Na, Ca and Mg, respectively.

Elsemeih, 90 km South east Elobeid city, longitude 30^0 38' 1, latitude 120 43' 18, soil with 43.4% sand, 7.5% silt, 49.1% clay, 0.03% N, 0.06% P, 0.7% O.C, 7.5 pH value and 0.10, 8.3, 2.00 and 1.30 meq/l K, Na, Ca and Mg, respectively.

The experiment was arranged in split plot design with four replications. The land was prepared by deep ploughing, harrowing and leveling. Then it was ridged and divided into 3.0×9.0 m plots.

Seeds were treated as follows:

1. Inoculated with *bradyrhizobium spp*. strains TAL 169 and TAL 1371 (Introduced).
2. Inoculated with *bradyrhizobium spp*. strains ENRRI 16A and ENRRI 16C (Local).
3. Uninoculated (control).

Estimation of Yield Attributes:

From each plot, after four weeks from sowing date, six plants were randomly taken to calculate the number of nodules.

At harvest, six plants were randomly obtained from each plot to estimate plant height (cm), number of fruiting branches/plant, number of pods /plant,100 seeds weight (g), grain yield (g) and yield (kg/ha).

Chemicals Analysis:

Proximate analysis: was determined according to AOAC, (1995).

Minerals: Samples were dry ashed Walsh, (1980) as follows: in a digestion chamber about 1.0 g sample was acid-digested with diacid mixture (HNO_3:$HClO_4$, 5:1 v/v). The digested sample was dissolved in double–distilled water and filtered (whatman No.42). The filtrate was made to 50 ml with double–distilled water and was used for the determination of five minerals. Calcium and magnesium were determined by titration method as described by Duncan, (1955). Sodium and potassium were determined using flame photometer (CORING EEL, London, UK) according to Baboo and Rona, (1995) method. Phosphorus was determined according to Scheff and pajenkam, (1952) method.

Statistical Analysis:

Each sample was analysed in triplicate and the figures were then averaged. Data were assessed by analysis of variance (ANOVA), Snedecor and Cochran, (1987) using CRD and by Duncan's multiple range test with a probability $P \leq 0.05$ Duke, (1981).

RESULTS and DISCUSSION

Effect of Bradyrhizobium Inoculation on Yield Attributes:

As shown in Tables 1 and 2, inoculation with *Bradyrhizobium* strains ENRRI 16A, ENRRI 16C, TAL 169 and TAL1371 significantly ($p \leq 0.05$) increased plant height at Elsemeih location by 22%, 20%, 22% and 21%, respectively compared to the control. Similar results were reported by Stafford and Seiler, (1986). On the other hand insignificant variations in plant height were observed at Bara site.

Inoculation with ENRRI 16A, ENRRI 16C, TAL 169 and TAL 1371 significantly ($p \leq 0.05$) increased the number of fruiting branches/plant by 49%, 66%, 49% and 12%, respectively in Bara site. The same strains significantly ($p \leq 0.05$) increased the number of fruiting branches by 65%, 36%, 38% and 36%, respectively in Elsemeih site (Table 2). These results were in line with the findings of Adam, (1995).

Bradyrhizobium strains, ENRRI 16A, ENRRI 16C and TAL 169 significantly ($p \leq 0.05$) increased the number of pods at harvesting (Table 1) by 65%, 88%, and 32%, respectively compared to the control at Bara site (Table 1). Similar results were reported by Stafford and Seiler, (1986) and Yadava and Manju, (1985). In contrast, all tested strains showed no effect on the number of pods at Elsemeih.

Obviously, inoculation with *Bradyrhizobium* exerted no effect on the 100-seed weight in the two sites (Table 1 and 2). Comparable results were reported by Burseglove, (1984).

Inoculation with the four strains used insignificantly increased the grain yield as well as the yield kg/ha in both sites (Table 3) compared to the uninoculated control. Inoculation was found to be positively correlated with grain yield of legumes crops such as faba bean Abdelmua *et al.,* (1995), hyacinth bean Abdel-Hafeez, (2001) and fenugreek Abdelgani *et al.,*(2003). Current results of yield were in contrast with the findings in other legumes such as faba bean Gumma.a, (1999); ground nut Mohammed Zein, (1996) and fenugreek Abdelgani *et al.,*(2003).

Inoculation proved to be effective in increasing the yield of guar genotypes (Singh and Singh 1989). Environmental and biotic factors such as inoculation, the presence and quality of indigenous rhizobial population, soil nitrogen content, soil physiochemical constraints and climatic conditions are important factors in determining the yield of crops. These factors together with the suitability of the inoculum strain(s) determine success in inoculation programmes specifically Singleton *et al.,* (1992).

Effect of Bradyrhizobium Inoculation on Seed Proximate Composition:

As demonstrated in Tables 4, inoculation by *Bradyrhizobium* strain*s* insignificantly ($p \leq 0.05$) affected moisture, ash and oil contents of the tested guar cultivars at Bara location. At Elsemeih site (Table 5), moisture and oil (except for TAL 1371) followed the same trend. Exceptionally, the ash content significantly increased as a result of treatment. However, moisture content of guar seeds was reported to be influenced by the relative humidity of surrounding atmosphere at the time of harvest and during storage (Elsheikh, 2001; 1999).

The inoculation with *Bradyrhizobium* strains (except for TAL 169) significantly increased the crude fibre of the tested genotypes at Bara site (Table 6), while at Elsemeih site inoculation failed to enhance fibre content (Table 7). Similar results were reported by Khatta *et al.,* (1988). The crude fibre content is an important constituent of human food and animal feed and it is needed in a reasonable proportion as it gives the bulk to the diet and helps in movement of food through the digest Abdelgani, (1997).

It is clear that protein content of guar seeds at Bara site (Tables 6) was not subjective to *Bradyrhizobium* inoculation; this could be probably due to deficiency of fixed nitrogen, to be transformed to the seeds, in the nodules. Conversely, protein content of all guar cultivars at Elsemeih showed significant improvement (Table 7).

Inoculation with all *Bradyrhizobium* strains, except for the local strains at Elsemeih, exerted no effect on carbohydrate content of guar seeds in the two locations (Tables 6 and 7). Generally, the carbohydrates content in the seeds of legumes crops was found to be decrease with *Rhizobium* inoculation Elsheikh *et al.,* (1999).

Effect of Bradyrhizobium Inoculation on Minerals Content:

In this study inoculation with the locally isolated strains (ENRRI 16A and ENRRI 16C) as well as the introduced strains (TAL 169 and TAL 1371) of *Bradyrhizobium* failed to make significant increase in the mean phosphorus content of guar seeds at both Bara and Elsemeih sites (Tables 8 and 9).

Bradyrhizobium strains ENRRI 16C, TAL 169 and TAL 1371, at Bara location (Table 8), significantly ($p \leq 0.05$) increased the mean potassium content compared to the uninoculated control. At Elsemeih site (Table 9), only the local strain ENRRI 16A significantly ($p \leq 0.05$) elevated the mean potassium content of guar seeds from 26.11 to 27.55%. Present results were in good agreement with the findings of Elshiekh, (1993).

The mean sodium content of guar seeds was significantly ($p \leq 0.05$) increased due to inoculation with local ENRRI 16A and the introduced TAL 1371 *Bradyrhizobium* strains (by 6% and 33% respectively) matched up to the control at Bara site (Table 8). Conversely, treatment with *Bradyrhizobium* failed to change sodium content at Elsemeih site (Table 9).

As a result of inoculation with *Bradyrhizobium* strains, only insignificant increases in the mean calcium and magnesium contents of guar seeds were observed at both Bara and Elsemeih sites (Table 10). Elshiekh, (1993) reported that inoculation significantly increased calcium content of guar genotypes. Correspondingly, (23) reported that calcium, potassium and sodium content of ground nut seeds significantly increased due to *Bradyrhizobium* inoculation.

Conclusion:

Bradyrhizobium inoculation significantly increased number of fruiting branches/plant, plant height (cm),number of pods/plant and protein content. However, strains improvement the potassium and sodium content of guar genotypes.

Table 1: Effect of inoculation with four ***Bradyrhizobium*** strains on plant height (cm), fruiting branches/plant, number of pods/plant) and 100-seed weight (g) of two cultivars of guar grown at Bara location.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
plant height (cm)						
HFG–75	90.63	95.10	105.75	104.53	110.4 3	101.29
Local	95.15	105.61	101.53	104.75	98.48	100.50
Mean	92.89	98.85	103.64	104.64	104.45	
Fruiting branches/plant						
HFG–75	9.0	10.3	13.3	11.8	7.8	10.4
Local	7.5	14.5	14.1	12.8	10.8	11.9
Mean	8.3c	12.4a	13.8a	12.4a	9.3bc	
number of pods/plant						
HFG–75	47.25	81.50	123.0	105.50	63.50	84.15
Local	82.0	133.75	145.50	138.25	107.25	121.35
Mean	64.63c	107.63ab	134.25a	121.88ab	85.38ac	
100-seed weight (g)						
HFG–75	3.15	2.76	2.96	3.09	3.03	2.99
Local	3.06	3.16	3.03	3.08	3.81	3.03
Mean	3.01	3.96	3.01	3.08	2.92	

Treatments	LSD 0.05			
	plant height (cm)	fruiting branches/plant	number of pods/plant	100-seed weight (g)
Guar Cultivar	4.48	1.30	33.4	0.24
Strains	14.72	3.07	42.31	0.36
Interaction	15.48	3.23	44.48	0.39

Table 2: Effect of inoculation with four ***Bradyrhizobium*** strains on plant height (cm), fruiting branches/plant), number of pods/plant) and 100-seed weight (g) of two cultivars of guar grown at Elsemeih location.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
plant height (cm)						
HFG–75	48.73	61.4	62.0	65.63	59.45	59.44
Local	51.03	60.18	57.9	56.53	61.05	57.34
Mean	49.88a	60.79b	59.95b	61.08b	60.25b	
fruiting branches/plant						
HFG–75	4.0	6.0	6.0	6.5	6.8	5.9
Local	4.3	7.5	5.3	6.5	4.5	5.6
Mean	4.13a	6.8b	5.6a	6.5a	5.6a	
number of pods/plant						
HFG–75	35.75	60.5	53.0	66.0	62.50	55.55
Local	35.0	70.25	49.25	64.50	50.50	53.90
Mean	35.38	65.38	51.13	65.25	56.50	
100-seed weight (g)						
HFG–75	3.68	3.69	3.59	3.70	3.74	3.66
Local	3.58	3.54	3.73	3.68	3.68	3.64
Mean	3.63	3.62	3.66	3.69	3.66	

Treatments	LSD 0.05			
	plant height (cm)	fruiting branches/plant	number of pods/plant	100-seed weight (g)
Guar Cultivar	8.05	1.72	21.48	0.16
Strains	7.16	2.36	30.45	0.24
Interaction	7.52	2.48	32.01	0.25

Table 3: Effect of inoculation with four ***Bradyrhizobium*** strains on Grain yield (g/plant) and yield (kg/ha) of two cultivars of guar grown at Bara and Elsemeih locations.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
Grain yield (g/plant), Bara						
HFG–75	8.07	9.43	8.21	6.58	7.62	7.98
Local	6.41	9.19	9.74	7.84	7.62	8.16
Mean	7.24	9.31	8.97	7.20	7.62	
Grain yield (g/plant), Elsemeih						
HFG–75	6.69	11.39	11.98	11.42	9.71	10.24
Local	7.17	10.23	13.98	15.52	11.16	11.61
Mean	6.93	10.81	12.98	13.47	10.44	
Yield (kg/ha), Bara						
HFG–75	120.73	209.43	187.40	146.15	169.23	179.79
Local	124.28	191.68	216.30	174.18	169.23	175.13
Mean	122.51	200.55	201.85	160.17	169.23	
Yield (kg/ha) , Elsemeih						
HFG–75	148.73	253.15	266.13	253.85	215.78	227.53
Local	159.23	227.33	310.23	344.78	248.08	257.93
Mean	153.98	240.24	288.18	299.31	231.93	

Treatments	LSD 0.05			
	Grain yield (g/plant), Bara	Grain yield (g/plant) Elsemeih	Yield (kg/ha) Bara	Yield (kg/ha) Elsemeih
Guar Genotype	3.06	3.59	58.13	79.56
Strains	4.96	6.65	107.2	147.7
Interaction	5.21	6.99	112.7	155.3

Table 4: Effect of inoculation with four ***Bradyrhizobium*** strains on seed moisture (%), ash (%) and Oil (%) of two cultivars of guar grown at Bara location.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
Moisture %						
HFG–75	3.2	5.53	4.20	3.20	4.57	4.54
Local	3.5	4.67	5.70	4.73	4.03	4.83
Mean	3.35	5.10	4.95	3.97	4.30	
Ash %						
HFG–75	3.67	5.00	2.83	2.83	3.33	3.53
Local	2.83	4.33	4.17	4.17	3.83	3.87
Mean	3.25	4.67	3.50	3.50	3.58	
Oil %						
HFG-75	2.17	3.17	2.83	4.00	3.00	3.03
Local	1.33	2.67	2.67	3.33	3.67	2.73
Mean	1.75	2.92	2.75	3.67	3.33	

Treatments	LSD 0.05		
	Moisture %	Ash %	Oil %
Guar Genotype	0.98	1.61	0.16
Strains	1.78	1.63	2.38
Interaction	1.87	1.71	2.51

Table 5: Effect of inoculation with four *Bradyrhizobium* strains on seed moisture (%), ash (%) and Oil (%) of two cultivars of guar grown at Elsemeih location.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
Moisture %						
HFG – 75	6.50	6.83	6.67	6.33	6.50	6.57
Local	6.50	6.83	6.67	7.40	6.83	6.85
Mean	6.50	6.83	6.67	6.87	6.67	
Ash %						
HFG – 75	2.8	3.50	3.33	3.67	3.50	3.36
Local	3.1	3.33	3.50	3.50	3.67	3.42
Mean	2.95	3.42	3.42	3.58	3.58	

Table 5: Continue

Oil%						
HFG – 75	1.5	3.33	3.17	1.83	5.33	3.32
Local	1.67	4.50	2.17	1.50	4.83	2.93
Mean	1.59	3.92	2.67	1.67	5.08	
Treatments				LSD 0.05		
		Moisture %		Ash %		Oil %
Guar Genotype		0.52		0.64		1.72
Strains		0.57		0.39		3.05
Interaction		0.60		0.40		3.21

Table 6: Effect of inoculation with four *Bradyrhizobium* strains on seed fiber (%), Protein (%) and Carbohydrates (%) of two cultivars of guar grown at Bara location.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
Fiber %						
HFG – 75	6.15	8.67	9.40	7.23	9.33	8.16
Local	6.75	9.60	8.23	7.97	8.53	8.22
Mean	6.45	9.13	8.82	7.60	8.93	
Protein %						
HFG – 75	26.50	31.37	26.10	32.23	27.0	28.64
Local	24.37	30.17	28.43	22.87	29.37	27.04
Mean	25.44	30.77	27.27	27.55	28.18	
Carbohydrate %						
HFG – 75	45.80	46.30	54.63	50.50	52.77	50.00
Local	46.22	48.57	50.80	56.93	50.57	50.62
Mean	46.01	47.43	52.72	53.72	51.67	
Treatments				LSD 0.05		
		Fiber %		Protein %		Carbohydrate %
Guar Genotype		1.08		4.33		4.36
Strains		1.42		9.25		8.08
Interaction		1.49		9.73		8.49

Table 7: Effect of inoculation with four *Bradyrhizobium* strains on seed fiber (%), Protein (%) and Carbohydrates of two cultivars of guar grown at Elsemeih location.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
Fiber %						
HFG – 75	8.80	10.10	9.10	9.57	9.33	9.38
Local	9.0	9.90	9.0	10.90	11.37	10.03
Mean	8.90	10.0	9.05	10.23	10.35	
Protein %						
HFG – 75	30.03	37.50	35.60	39.13	35.0	35.45
Local	32.1	33.23	31.63	39.83	35.30	34.42
Mean	31.07b	35.37bc	33.62c	39.48a	35.15bc	
Carbohydrate %						
HFG – 75	36.2	38.73	42.23	39.47	40.33	39.39
Local	37.8	42.20	43.70	36.87	37.33	39.58
Mean	37.0	40.47	42.97	38.17	38.83	
Treatments				LSD 0.05		
		Fiber %		Protein %		Carbohydrate %
Guar Genotype		1.37		3.18		3.28
Strains		2.05		3.40		3.28
Interaction		2.16		3.40		7.77

Table 8: Effect of inoculation with four *Bradyrhizobium* strains on seed phosphorus, potassium and sodium contents of two cultivars of guar grown at Bara location.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
Phosphorus %						
HFG – 75	0.47	0.48	0.48	0.37	0.37	0.44
Local	0.39	0.65	0.66	0.65	0.54	0.58
Mean	0.43ab	0.57a	0.57c	0.51ab	0.45bc	
Potassium mg/100g						
HFG – 75	24.83	26.17	27.45	25.97	26.7	26.22
Local	23.10	27.77	29.60	29.33	28.10	27.58
Mean	23.97	26.97	28.53	27.65	27.40	
Sodium mg/100g						
HFG – 75	4.25	4.77	6.07	5.83	4.93	5.17
Local	3.75	4.20	5.37	4.93	4.60	4.57
Mean	3.97abc	4.48c	5.72a	5.38ab	4.77bc	

Treatments	LSD 0.05		
	Phosphorus %	Potassium mg/100g	Sodium mg/100g
Guar Genotype	0.09	1.22	0.26
Strains	0.21	3.32	0.82
Interaction	0.22	3.54	0.86

Table 9: Effect of inoculation with four *Bradyrhizobium* strains on seed phosphorus, potassium and sodium contents of two cultivars of guar grown at Elsemeih location.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
Phosphorus %						
HFG – 75	0.20	0.53	0.38	0.27	0.38	0.35
Local	0.28	0.45	0.21	0.41	0.44	0.36
Mean	0.24	0.49	0.30	0.34	0.41	
Potassium mg/100g						
HFG – 75	26.10	28.00	26.83	27.63	26.83	27.08
Local	26.13	27.10	27.20	26.70	27.20	26.87
Mean	26.11	27.55	27.02	27.17	27.02	
Sodium mg/100g						
HFG – 75	5.63	5.77	6.27	5.93	8.40	6.40
Local	5.33	12.00	6.23	5.93	6.83	7.26
Mean	2.19	8.88	6.25	5.93	7.62	

Treatments	LSD 0.05		
	Phosphorus %	Potassium mg/100g	Sodium mg/100g
Guar Genotype	0.26	0.71	3.96
Strains	0.24	1.19	5.26
Interaction	0.25	1.26	5.12

Table 10: Effect of inoculation with four *Bradyrhizobium* strains on seed Calcium and Magnesium contents of two cultivars of guar grown at Bara and Elsemeih locations.

Cultivar	Treatments					
	Control	ENRRI 16A	ENRRI 16C	TAL 169	TAL 1371	Mean
Calcium mg/100g, Bara						
HFG – 75	108.67	138.50	181.33	183.13	143.53	151.03
Local	123.73	136.30	245.6	194.73	120.60	164.21
Mean	116.20	137.40	213.50	188.93	132.07	
Magnesium mg/100g, Bara						
HFG – 75	122.80	118.57	157.27	156.47	130.17	137.07
Local	109.33	142.30	183.47	200.43	182.87	163.68
Mean	116.07	130.43	170.37	178.45	160.52	
Calcium mg/100g, Elsemeih						
HFG – 75	184.03	252.13	246.40	251.83	216.13	230.11
Local	114.67	210.13	198.90	231.00	252.23	201.39
Mean	149.35	231.13	222.65	241.42	234.18	

Table 10: Continue

Magnesium mg/100g, Elsemeih					
HFG – 75	168.47	177.07	168.00	173.10	214.10	180.15
Local	167.53	211.17	230.40	214.87	178.77	200.55
Mean	168.00	194.12	199.20	193.98	196.43	

Treatments	LSD 0.05			
	Calcium (mg/100g), Bara	Magnesium (mg/100g), Bara	Calcium (mg/100g), Elsemeih	Magnesium (mg/100g), Elsemeih
Guar Genotype	16.78	26.12	103.2	50.44
Strains	97.33	73.68	91.45	107.7
Interaction	102.3	77.46	96.14	113.2

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