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ENHANCEMENT OF GUAR GROWTH AND PRODUCTIVITY BY *Bradyrhizobium* INOCULATION UNDER DIFFERENT NPK FERTILIZATION LEVELS

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ABSTRACT: Two field experiments were carried out during the two consecutive summer seasons of 2019 and 2020 at Experimental Farm (Ghazala Farm) of Agric. Fac., Zagazig Univ., Egypt. This study was to try to enhance the growth and yield of guar plant. The experiment was set up as split-plot design between NPK fertilization as main plot and bio-fertilization as sub-plot. The NPK fertilization levels were (0.0, 75, 100 and 125% of recommended level), while, the *Bradyrhizobium* inoculation rates were (0.0, 200 and 400 g/feddan). The NPK fertilization recommended rate (RR) was Ammonium sulfate (20.5% N) at 200 kg/feddan, calcium super phosphate (15.5% P_2O_5) at 200 kg/feddan and potassium sulfate (48% K_2O) at 100 kg/feddan. The obtained results revealed that fertilized guar plants with 125% RR significantly increased plant growth (plant height, number of leaves and branches/ plant, fresh and dry weights of branches, leaves and roots/plant and root length), yield components (pods number per plant and seed yield per plant and per feddan) as well as total carbohydrates content compared to control and the other levels under study. Moreover, the highest *Bradyrhizobium* inoculation rate (400 g/feddan) significantly recorded the highest values of all abovementioned parameters compared to control and lowest one. Predominantly, the results of this study showed that fertilized guar plants with 125% RR of NPK fertilization could help to enhance growth and productivity of guar (*Cyamopsis tetragolnoloba* Taub.) plant combined with 400 g/feddan of *Bradyrhizobium* inoculation rate under Sharkia Governorate conditions.

Key words: *Cyamopsis tetragonoloba*, NPK, bio-fertilization, growth and yield

INTRODUCTION

Guar or cluster bean (*Cyamopsis tetragonoloba*, Taub.) belongs to Leguminosae family, it is big demand for guar gum products, food thickener and food additives. Guar is a multi-objective legume crop cultivated fundamentally in the summer season, it is drought-tolerant and it is utilized as animal fodder and feed, green manure and for extraction of gum for different industrial utilizes (**Baviskar *et al.*, 2010**). It is from the endosperm that guaran gum is deduced, which is the first popular product of the guar plant. The round endosperm contains significant amount of guaran gum (19-43% of the full seed), which forms a viscous gel in acidified alcohol (**Chavan *et al*., 2015**).

Nitrogen (N), phosphorus (P) and potassium (K) are essential nutrient elements in plant development and growth as will as they are involved in nucleic acid metabolism, protein synthesis, photosynthesis, carbohydrate metabolism, enzyme activity and nitrogen fixation (**Thakur and Sharma, 1997; Barbulova *et al*., 2007; Qin *et al*., 2012**). **Gavrić *et al*. (2021**) pointed out that the herb fresh and dry yield per plant with fertilizer NPK fertilization (7:20:30) treatment were better than control (unfertilized basil plants). Among the different NPK treatments, the application of NPK fertilization at 6:3:3 rates gave the highest values for growth traits, root parameters and greenness level of *Salvadora persica* plant (**Lasheen *et al*., 2021**).

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Biological nitrogen fixation is one direction of switching elemental nitrogen into plant utilizable form (**Gothwal *et al.*, 2007**). The formation of efficient root nodules leads to nitrogen fixation (*Bradyrhizobium* strains), which creates nitrogen mineral fertilizers more attainable **(Delić *et al.*, 2010)**. Furthermore, **Nyoki and Ndakidemi (2014)** found that bradyrhizobium inoculation and supplementation of phosphorus independently or in combination had positive influences on growth, grain yield, leaf chlorophyll content and nitrogen fixation. Likewise, **Abdou *et al.* (2020)** vegetative and yield parameters of fennel plant was significantly increased by all utilized bio-fertilization treatments compared with control (un-inoculated plants).

In addition, **Khalil *et al.* (2019)** indicated that, the highest values of growth parameters and chemical composition of celery plant obtained at inoculating seeds with mixture of mycorrhizal and mycrobein at full dose of NPK. Also, **Elsayed *et al.* (2020)** suggested that the best fertilization treatments were bio-fertilizer and 100% chemical fertilizer for plant growth and chemical constituents (plant height, leaves number per plant, pigment content and total carbohydrate percentage) of two dill genotypes.

The main objective of the present study was to investigate the influence of different NPK fertilizers levels, *Bradyrhizobium* rates and their combinations on the growth and yield as well as total chlorophyll content and total carbohydrates of guar plant under Sharkia Governorate conditions.

MATERIALS AND METHODS

Two field experiments were done during the two summer consecutive seasons of 2019 and 2020 at Experimental Farm (Ghazala Farm) of Agric. Fac., Zagazig Univ., Egypt. This study was conducted to investigate the influence of different levels of NPK fertilization (0.0, 75, 100 and 125% recommended rate), *Bradyrhizobium* rates (0.0, 200 and 400 g/feddan) and their combination treatments on plant growth and yield components as well as total chlorophyll content and total carbohydrates percentage of guar (*Cyamopsis tetragonoloba*, Taub.) plant. The NPK fertilization recommended rate (RR) were ammonium sulfate (20.5% N) at 200 kg/ feddan, calcium super phosphate (15.5%P_2O_5) at 200 kg/feddan and potassium sulfate (48% K_2O) at 100 kg/feddan. Table 1 reveals physical and chemical analysis of the experimental soil (average of both seasons) at a depth of 0-30 cm as reported by **Chapman and Pratt (1978**).

Experimental Design

The current experiment was set up in a split-plot design with three replicates. The main plots were occupied by four NPK fertilization levels. While, the sub plots were entitled to three *Bradyrhizobium* rates. The combination between the main factor and the sub factor resulted in 12 combination treatments.

The experimental unit area was 14.70 m^2 (3.50 ×4.20 m) included six ridges. Each ridge was 60 cm wide and 3.50 meters length. The distance between hills in the ridge was 30 cm, under surface irrigation system. The guar seeds were sown in the experimental units on 12th and 16th October during the 2019 and 2020 seasons, respectively. Then it immediately irrigated. After complete germination at 15 days after sowing seeds were thinned to be two plants per hill.

Guar seeds were inoculated *Bradyrhizobium* before sowing. The adhesive agent used was Arabic gum 20%. The inoculated seeds were left in a shaded place for about one hour before sowing for air drying. Also, different levels of nitrogen and potassium fertilizers were divided into three equal levels and were added to the soil at 35, 60 and 85 days after sowing date of guar seeds. While, different levels of phosphorus were applied during soil preparation. All recommended agricultural practices of growing guar plants were done when ever needed.

Recorded Data

Plant growth

After 102 days from sowing date of guar, a sample of 3 plants were randomly taken from each experimental unit and plant growth parameters noticed as plant height (cm), number of branches/plant and number of leaves/plant as well as fresh and dry weights of branches, leaves and roots/plant (g) and root length were recorded.

Table 1. Physical and chemical properties of experimental farm soil (average of both seasons)

Mechanical analysis			Soil texture
Clay (%)	Silt (%)	Coarse sand (%)	Loamy
43.70	31.90	24.40	

Chemical analysis													
pH	E.C. (dsm^{-1})	Soluble cations (m.mol/l)						Soluble anions (m.mol/l)			Available (ppm)		
		Ca^{++}	Mg^{++}	Na^{+}	Fe	Zn^{++}	Mo^{++}	Cl^{-}	HCO_3^{-}	SO_4^{--}	N	P	K
7.80	1.56	2.10	2.80	0.90	0.30	1.65	1.42	3.40	4.08	1.30	155	89	73

Yield and its components

At harvesting stage (after 160 days from sowing date) the yield components expressed as number of pods per plant, seed yield/plant (kg) and seed yield/feddan (kg) were recorded.

Chemical constituents

Total chlorophyll content (SPAD unit) was determined in fresh leaves of guar plant after 102 days from sowing date by using SPAD- 502 meter (**Markwell *et al.*, 1995**). Also, total carbohydrates percentage in guar seeds was determined according to **Chapman and Pratt (1978)** at the end of experiment.

Statistical Analysis

Collected data of current reseasrch were analyzed according to **Gomez and Gomez (1984)**. Least significance difference (LSD) was used to differentiate means at the at 5 % level of probability. The means were compared utilizing computer program of Statistix version 9 (**Analytical Software, 2008**).

RESULTS AND DISCUSSION

Plant Growth

Data presented in Tables 2 , 3, 4 and 5 show that, using NPK fertilization treatments at high levels (100 and 125% RR) significantly increased plant height, branch and leaf numbers per guar plant and branches, leaves and roots fresh and dry weights/plant and root length compared to control and the lowest level (75 % RR) in both seasons. Generally, guar plant growth parameters were increased in gradual with increasing of the levels of NPK to reach its maximum by using that of 125% of recommended rat (RR). Furthermore, all *Bradyrhizobium* rate treatments significantly increased guar plant height and branch and leaf numbers per guar plant as well as branches, leaves and roots fresh and dry weights/plant and root length compared to un-inoculated seeds (control). Using 400 g/feddan of *Bradyrhizobium* significantly increased plant growth parameters of guar compared to control and the other rates under study. The increases in number of branches per plant were about 46.58 and 49.21% for 400 g/feddan rate over control treatment in the 1st and 2nd seasons, respectively. These results hold true in the 2019 and 2020 seasons. The combination treatment between NPK fertilization at 125% RR and *Bradyrhizobium* at 400 g/feddan significantly increased guar growth parameters compared to control and the other ones under study in both seasons. In addition, increasing *Bradyrhizobium* rates under each NPK fertilization level gradually increased guar growth parameters.

Moreover, the NPK nutrients play serious roles in photosynthesis, transpiration, osmotic regulation and respiration (**Eleiwa *et al.*, 2012**). Moreover, Applying NPK fertilizer to basil plant produced the highest growth traits (**Alhasan *et al.*, 2020**).

Also, the simulative effect of *Rhizobium* inoculation on fenugreek growth and dry weight/ plant may be due to its ability for fixing nitrogen element from atmosphere which considers the main nutrient element for plant growth **(Hamad, 2014**). Generally, as mentioned just before, both NPK fertilization and bio-fertilization treatments (each alone) increased plant growth, in turn, they together might maximize their influences leading to tallest plant, more leaves and branches per plant as well as heaviest branches, leaves and root per plant.

Table 2. Effect of NPK fertilization level (A) and *Bradyrhizobium* inoculation rate (B) and their interaction (A×B) treatments on plant height, number of branches and leaves /plant of guar plants during the two seasons of 2019 and 2020

NPK fertilization level (% RR*)	*Bradyrhizobium* inoculation rate (g/feddan)							
	0.0	200	400	Mean (A)	0.0	200	400	Mean (A)
	2019 season				2020 season			
	Plant height (cm)							
0.0	111.55	118.11	119.11	**116.26**	107.89	112.33	115.00	**111.74**
75	112.45	120.11	122.45	**118.33**	109.67	116.22	119.33	**115.07**
100	116.89	121.78	126.56	**121.74**	113.55	125.78	131.11	**123.48**
125	118.44	126.56	131.22	**125.41**	123.45	134.44	139.11	**132.33**
Mean (B)	**114.83**	**121.64**	**124.83**		**113.64**	**122.19**	**126.14**	
LSD at 5%	**A= 2.04**	**B= 1.06**	**A×B= 2.67**		**A= 1.80**	**B= 1.38**	**A×B= 2.88**	
	Number of branches/plant							
0.0	4.66	5.45	6.11	**5.41**	4.44	4.78	5.89	**5.04**
75	5.11	6.00	6.78	**5.96**	5.22	5.44	6.67	**5.78**
100	5.89	7.00	8.22	**7.06**	6.00	6.22	7.11	**6.44**
125	6.22	8.00	9.56	**7.93**	6.11	6.78	9.67	**7.52**
Mean (B)	**5.47**	**6.61**	**7.67**		**5.44**	**5.81**	**7.33**	
LSD at 5%	**A= 0.67**	**B= 0.37**	**A×B= 0.90**		**A= 0.78**	**B= 0.86**	**A×B= 1.60**	
	Number of leaves/plant							
0.0	59.11	66.89	72.78	**66.26**	63.22	70.56	74.00	**69.26**
75	72.00	79.11	88.22	**79.78**	70.22	79.00	92.00	**80.41**
100	81.33	94.78	104.22	**93.44**	86.78	102.22	106.89	**98.63**
125	88.33	114.78	119.56	**107.55**	90.78	112.00	123.00	**108.59**
Mean (B)	**75.19**	**88.89**	**96.20**		**77.75**	**90.95**	**98.97**	
LSD at 5%	**A= 1.87**	**B= 1.91**	**A×B= 3.63**		**A= 2.41**	**B= 1.54**	**A×B= 3.48**	

* Recommended rate (RR): Ammonium sulfate (20.5% N) at 200 kg/feddan, calcium super phosphate (15.5%P_2O_5) at 200 kg/feddan and potassium sulfate (48 % K_2O) at 100 kg / feddan.

Table 3. Effect of NPK fertilization level (A) and *Bradyrhizobium* inoculation rate (B) and their interaction (A×B) treatments on fresh and dry weights of branches /plant (g) of guar plants during the two seasons of 2019 and 2020

NPK fertilization level (% RR*)	*Bradyrhizobium* inoculation rate (g/feddan)							
	0.0	200	400	Mean (A)	0.0	200	400	Mean (A)
	2019 season				2020 season			
	Fresh weight of branches/plant (g)							
0.0	72.58	75.94	77.84	**75.45**	69.51	74.45	81.25	**75.07**
75	80.66	83.50	83.96	**82.71**	70.39	77.36	92.67	**80.14**
100	84.41	90.09	103.06	**92.52**	75.54	103.13	113.47	**97.38**
125	85.14	98.34	113.16	**98.88**	92.92	110.20	129.58	**110.90**
Mean (B)	**80.70**	**86.97**	**94.51**		**77.09**	**91.28**	**104.24**	
LSD at 5%	**A= 1.74**	**B= 2.13**	**A×B= 3.88**		**A= 2.17**	**B= 0.93**	**A×B= 2.65**	
	Dry weight of branches/plant (g)							
0.0	19.95	22.34	23.90	**22.07**	18.15	20.43	23.93	**20.84**
75	25.70	26.31	26.54	**26.18**	19.88	21.87	30.00	**23.91**
100	26.92	28.88	32.20	**29.33**	22.24	32.24	34.35	**29.61**
125	26.76	30.12	34.97	**30.62**	30.20	32.58	38.11	**33.63**
Mean (B)	**24.83**	**26.91**	**29.40**		**22.62**	**26.78**	**31.59**	
LSD at 5%	**A= 0.58**	**B = 0.72**	**A×B= 1.31**		**A= 0.81**	**B= 0.64**	**A×B= 1.31**	

*Recommended rate (RR): Ammonium sulfate (20.5% N) at 200 kg/feddan, calcium super phosphate (15.5%P_2O_5) at 200 kg/feddan and potassium sulfate (48 % K_2O) at 100 kg / feddan.

Table 4. Effect of NPK fertilization level (A) and *Bradyrhizobium* inoculation rate (B) and their interaction (A×B) treatments on fresh and dry weights of leaves/plant (g) of guar plants during the two seasons of 2019 and 2020

NPK fertilization level (% RR*)	*Bradyrhizobium* inoculation rate (g/feddan)							
	0.0	200	400	Mean (A)	0.0	200	400	Mean (A)
	2019 season				2020 season			
	Fresh weight of leaves/plant (g)							
0.0	136.42	138.46	142.26	**139.05**	141.44	144.17	147.41	**144.43**
75	140.79	147.20	148.83	**145.61**	145.34	150.14	154.68	**150.05**
100	150.70	158.50	174.80	**161.33**	156.42	170.60	185.40	**170.81**
125	157.18	169.03	180.82	**169.01**	157.98	176.76	192.61	**175.78**
Mean (B)	**146.27**	**153.30**	**161.68**		**150.29**	**160.42**	**170.03**	
LSD at 5%	**A= 3.83**	**B= 2.55**	**A×B= 5.64**		**A= 2.14**	**B= 4.77**	**A×B= 8.07**	
	Dry weight of leaves/plant (g)							
0.0	13.70	14.16	14.56	**14.14**	14.49	14.82	15.22	**14.84**
75	14.29	15.12	15.74	**15.05**	14.94	15.72	16.14	**15.60**
100	14.67	16.61	18.23	**16.50**	14.68	17.93	20.07	**17.56**
125	15.97	16.96	18.81	**17.25**	16.30	17.68	20.51	**18.16**
Mean (B)	**14.66**	**15.71**	**16.84**		**15.10**	**16.54**	**17.98**	
LSD at 5%	**A= 0.46**	**B = 0.48**	**A×B=0.90**		**A= 0.45**	**B= 0.53**	**A×B= 0.98**	

* Recommended rate (RR): Ammonium sulfate (20.5% N) at 200 kg/feddan, calcium super phosphate (15.5%P_2O_5) at 200 kg/feddan and potassium sulfate (48 % K_2O) at 100 kg / feddan.

Table 5. Effect of NPK fertilization level (A) and *Bradyrhizobium* inoculation rate (B) and their interaction (A×B) treatments on fresh and dry weights of roots /plant (g) and root length (cm) of guar plants during the two seasons of 2019 and 2020

NPK fertilization level (% RR*)	*Bradyrhizobium* inoculation rate (g/feddan)							
	0.0	200	400	Mean (A)	0.0	200	400	Mean (A)
	2019 season				2020 season			
	Fresh weight of roots/plant (g)							
0.0	21.38	23.37	24.46	**23.07**	20.13	21.89	23.97	**22.00**
75	23.86	26.12	27.53	**25.89**	23.05	25.69	28.20	**25.65**
100	25.40	26.02	29.22	**26.88**	25.76	28.61	31.03	**28.47**
125	26.23	29.48	34.43	**30.04**	30.53	32.37	34.87	**32.59**
Mean (B)	**24.22**	**26.25**	**28.91**		**24.87**	**27.14**	**29.52**	
LSD at 5%	**A= 0.70**	**B= 0.52**	**A×B= 1.10**		**A= 2.26**	**B= 1.46**	**A×B= 3.27**	
	Dry weight of roots/plant (g)							
0.0	7.52	8.52	9.62	**8.56**	6.95	7.47	8.24	**7.55**
75	8.38	8.29	10.07	**8.91**	7.58	9.14	10.51	**9.08**
100	8.31	8.65	10.42	**9.12**	8.46	9.14	11.23	**9.61**
125	8.77	11.23	12.98	**11.00**	8.24	11.70	13.06	**10.99**
Mean (B)	**8.24**	**9.17**	**10.77**		**7.81**	**9.36**	**10.76**	
LSD at 5%	**A= 0.46**	**B = 0.18**	**A×B= 0.54**		**A= 0.43**	**B= 0.25**	**A×B= 0.59**	
	Root length (cm)							
0.0	17.89	19.44	20.56	**19.30**	19.33	21.55	23.11	**21.33**
75	18.44	21.89	23.89	**21.41**	20.22	20.44	24.78	**21.81**
100	19.78	23.67	25.45	**22.96**	21.55	25.11	26.44	**24.37**
125	26.22	27.11	27.78	**27.04**	23.00	25.22	28.44	**25.56**
Mean (B)	**20.58**	**23.03**	**24.42**		**21.03**	**23.09**	**25.69**	
LSD at 5%	**A= 1.07**	**B= 0.62**	**A×B= 1.47**		**A= 0.89**	**B= 0.26**	**A×B= 0.98**	

* Recommended rate (RR): Ammonium sulfate (20.5% N) at 200 kg/feddan, calcium super phosphate (15.5%P_2O_5) at 200 kg/feddan and potassium sulfate (48 % K_2O) at 100 kg / feddan.

Yield Components and Chemical Constituents

Data listed in Tables 6 and 7 that, all NPK fertilization treatments significantly increased number of pods per plant, seed yield per plant (g) and seed yield per feddan (kg) as well as total chlorophyll content in leaves and total carbohydrates percentage in seeds of guar compared to control, in most cases, in both seasons. In general, a gradual increase in the recorded yield and its components as well as chemical constituents were noticed with increasing NPK fertilization levels from 75 to 125% RR in the two tested seasons. Also, using the highest rate of *Bradyrhizobium* under study gave the highest values in guar yield components and its chlorophyll and carbohydrates compared to control and the lowest rate under study. The increases in number of pods per plant were about 30.35 and 44.35 % as well as in seed yield per plant about 27.43 and 35.26% for 400 g/fed., and 125% RR over control (unfertilized plants) in the first and second seasons, respectively. In addition, all combination treatments between NPK fertilization level and *Bradyrhizobium* rate treatments significantly increased guar (*Cyamopsis tetragonoloba*) yield components and chemical constituents, in most cases, compared to control in both seasons. The plants which inoculated with *Bradyrhizobium* at 400 g/ feddan and fertilized with NPK at 125% RR resulted in the highest values in this regard in both seasons, followed by the combination treatment between that plants which inoculated with *Bradyrhizobium* at 200 or 400 g/feddan + 125 or 100% RR of NPK) in the 1st and 2nd seasons, respectively. The increases in seed yield/faddan (kg) were about 38.33 and 52.59 % for the combination between NPK fertilization at 125% RR + *Bradyrhizobium* at 400 g/feddan over control treatment (unfertilized plants without *Bradyrhizobium* inoculation) in the 1st and 2nd seasons, respectively.

Table 6. Effect of NPK fertilization level (A) and *Bradyrhizobium* inoculation rate (B) and their interaction (A×B) treatments on number of pods/plant, seed yield /plant (g) and seed yield /feddan (kg) of guar plants during the two seasons of 2019 and 2020

NPK fertilization level (% RR*)	*Bradyrhizobium* inoculation rate (g/feddan)							
	0.0	200	400	Mean (A)	0.0	200	400	Mean (A)
	2019 season				2020 season			
	Number of pods /plant							
0.0	84.33	89.22	92.67	**88.74**	78.89	81.11	87.33	**82.44**
75	86.89	95.44	101.11	**94.48**	81.56	85.89	93.11	**86.85**
100	92.66	99.89	116.33	**102.96**	98.55	110.56	122.00	**110.37**
125	103.55	118.44	125.00	**115.67**	107.44	121.67	127.88	**119.00**
Mean (B)	**91.86**	**100.75**	**108.78**		**91.61**	**99.81**	**107.58**	
LSD at 5%	**A= 1.00**	**B= 1.12**	**A×B= 2.08**		**A= 2.22**	**B= 1.37**	**A×B= 3.14**	
	Seed yield /plant (g)							
0.0	6.04	6.17	6.61	**6.27**	5.73	6.02	6.46	**6.07**
75	6.18	6.73	7.01	**6.64**	5.99	6.32	6.86	**6.39**
100	6.20	7.22	8.16	**7.19**	6.14	7.95	8.38	**7.49**
125	7.42	8.19	8.36	**7.99**	7.64	8.25	8.74	**8.21**
Mean (B)	**6.46**	**7.08**	**7.54**		**6.38**	**7.14**	**7.61**	
LSD at 5%	**A= 0.19**	**B = 0.17**	**A×B= 0.33**		**A= 0.07**	**B= 0.10**	**A×B= 0.18**	
	Seed yield /feddan (kg)							
0.0	282.03	287.94	308.47	**292.81**	267.40	281.09	301.47	**283.32**
75	288.56	314.07	327.29	**309.97**	279.69	294.78	320.14	**298.20**
100	289.49	337.09	380.65	**335.74**	286.69	371.00	391.07	**349.59**
125	346.12	382.20	390.14	**372.82**	356.69	385.16	408.03	**383.29**
Mean (B)	**301.55**	**330.32**	**351.64**		**297.62**	**333.01**	**355.18**	
LSD at 5%	**A= 8.93**	**B= 7.75**	**A×B=15.46**		**A=3.32**	**B= 4.67**	**A×B= 8.31**	

* Recommended rate (RR): Ammonium sulfate (20.5% N) at 200 kg/feddan, calcium super phosphate (15.5%P_2O_5) at 200 kg/feddan and potassium sulfate (48 % K_2O) at 100 kg / feddan.

Table 7. Effect of NPK fertilization level (A) and *Bradyrhizobium* inoculation rate (B) and their interaction (A×B) treatments on total chlorophyll content (SPAD) and total carbohydrates percentage of guar plants during the two seasons of 2019 and 2020

NPK fertilization level (% RR*)	*Bradyrhizobium* inoculation rate (g/feddan)							
	0.0	200	400	Mean (A)	0.0	200	400	Mean (A)
	2019 season				2020 season			
	Total chlorophyll content (SPAD) in leaves							
0.0	43.44	43.67	44.67	**43.93**	40.56	42.78	44.11	**42.48**
75	43.78	44.33	45.44	**44.52**	42.00	42.56	43.44	**42.67**
100	44.55	45.11	45.89	**45.18**	42.78	45.67	46.67	**45.04**
125	44.00	45.11	45.78	**44.96**	42.78	45.56	47.100	**45.15**
Mean (B)	**43.94**	**44.56**	**45.45**		**42.03**	**44.14**	**45.33**	
LSD at 5%	**A=0.78**	**B= 0.36**	**A×B=0.97**		**A=0.23**	**B= 0.37**	**A×B=0.65**	
	Total carbohydrates percentage in seeds							
0.0	16.15	16.41	16.63	**16.40**	16.02	17.26	17.49	**16.92**
75	16.28	17.24	17.43	**16.98**	16.63	17.14	17.62	**17.13**
100	17.16	17.60	17.86	**17.54**	17.06	17.76	18.23	**17.69**
125	18.03	18.63	20.19	**18.95**	17.75	18.33	19.08	**19.39**
Mean (B)	**16.91**	**17.47**	**18.03**		**16.87**	**19.63**	**18.11**	
LSD at 5%	**A= 0.22**	**B = 0.27**	**A×B= 0.49**		**A= 0.18**	**B= 0.17**	**A×B= 0.33**	

* Recommended rate (RR): Ammonium sulfate (20.5% N) at 200 kg/feddan, calcium super phosphate (15.5%P_2O_5) at 200 kg/feddan and potassium sulfate (48 % K_2O) at 100 kg / feddan.

Generally, as mentioned above, both NPK fertilization and *Bradyrhizobium* inoculation (each alone) increased yield components and chemical constituents of guar plant, in turn; they together might maximize their influences leading more pods per plant as well as heaviest seed yield per plant and per feddan. Moreover, a suitable supply of NPK is in demand for optimum growth and yield output (**Thakur and Sharma, 1997; Barbulova *et al*., 2007; Qin *et al*., 2012**).

These results coincided with those found by **Khalid (2012)** on some medicinal *Apiaceae*, **Sharma *et al*. (2020)** on medicinal plants, **Gavrić *et al*. (2021**) on basil and **Lasheen *et al*. (2021)** on *Salvadora persica* plants regard NPK fertilization effect. In the same time, **Egamberdieva *et al*. (2018)** pointed out that soybean inoculated with an adequate amount of *Bradyrhizobium japonicum* gave optimal growth and development and maximize yield components.

Conclusion

Fertilization and inoculation of guar with suitable NPK level as well as strains of *Bradyrhizobium* is recommended to enhance the growth parameters, seed yield, and chemical constituents. NPK fertilization at 125% RR combined with 400 g/feddan *Bradyrhizobium* was the most favorable treatment for increasing plant growth, seed yield and total chlorophyll as well as seed carbohydrates percentage of *Cyamopsis tetragonoloba* plant.

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تحسين نمو وإنتاجية نبات الجوار عن طريق التلقيح بالبراديريزوبيم تحت مستويات المختلفة من التسميد النيتروجيني والفوسفاتي والبوتاسي

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أجريت تجربتان حقليتان خلال موسمي الصيف المتتاليين لعامي 2019 و2020 في المزرعة التجريبية (مزرعة غزالة)، كلية الزراعة، جامعة الزقازيق، مصر. كانت هذه الدراسة محاولة لتحسين نمو وإنتاجية نبات الجوار. صممت التجربة كقطع منشقة مرة واحدة بين التسميد النيتروجيني والفوسفاتي والبوتاسي في القطع الرئيسية والتلقيح الحيوي كقطع تحت رئيسية. كانت مستويات التسميد النيتروجيني والفوسفاتي والبوتاسي (صفر و75 و100 و 125% من المعدل الموصى به)، بينما كانت معدلات التلقيح براديرهيزوبيوم (صفر، 200 ، 400 جرام/ فدان). كان معدل التسميد الموصى به هو 200 كجم/فدان من سلفات الأمونيوم (20.5% نيتروجين)، و200 كجم/فدان من سوبر فوسفات الكالسيوم (15.5% خامس أكسيد الفسفور) و100 كجم/فدان من كبريتات البوتاسيوم (48% أكسيد البوتاسيوم). أظهرت النتائج المتحصل عليها أن نبات الجوار المسمد بمعدل 125% من المعدل الموصى به أدى إلى زيادة معنوية في نمو النبات (ارتفاع النبات، عدد الأوراق والأفرع/نبات، الأوزان الطازجة والجافة للأفرع، الأوراق والجذور لكل نبات وطول الجذر)، مكونات المحصول (عدد القرون لكل نبات ومحصول البذور للنبات وللفدان) وكذلك محتوى الكربوهيدرات الكلي مقارنة بالكنترول والمستويات الأخرى قيد الدراسة. علاوة على ذلك، سجل أعلى معدل من التلقيح بواسطة البراديرهيزوبيوم (400 جم/فدان) أعلى القيم معنوياً لجميع الصفات سالفة الذكر مقارنة بالكنترول والمعدل الأقل. أظهرت نتائج هذه الدراسة بشكل أساسي أن نباتات الجوار المسمد بمستوى 125% من المعدل الموصى به من التسميد النيتروجيني والفوسفاتي والبوتاسي يمكن أن تساعد في تحسين نمو وإنتاجية نبات الجوار مع التداخل مع 400 جم/فدان من معدل التلقيح من البراديرهيزوبيوم تحت ظروف محافظة الشرقية.

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