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Application of Bio-Organic Agriculture and its Effect on Guar (*Cyamopsis tetragonoloba* L.) Root Nodules, Forage, Seed Yield and Yield Quality

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Abstract: Two filed experiments were carried out at the New Salheyia Region, Sharkia Governorate, Egypt during the two successive seasons 2003 and 2004 to investigate the impact of certain bio-organic treatments consisted of farmyard manure (FYM), Rhizobium and/or soil yeast *(Rhodotorula glutinis)* on guar root nodules formation, forage yield, yield and its components as well as seeds nutrient content in comparison with the recommended traditional chemical treatment of NPK as a positive control. For root nodules formation, the diverse tested bio-organic treatments induced increases ranged from 25 to 100% over the positive control being the highest with 30 ton FYM/fed. + Rhizobium + Rhodotorula. Comparable results to the positive control were obtained for the forage yield per fed without significant differences. Moreover the highest forage yield was obtained due to the bio-organic treatment of 20ton. FYM/fed. + Rhizobium + Rhodotorula. The bio fertilization of guar with either Rhizobium as such or accompanied with Rhodotorula augmented seed yield / fed. where the percentage of increases ranged from 3% to 28% being the highest due to the dual inoculation with both bio fertilizers. The highest increase in biological yield per fed (36% over the positive control) was obtained due to the application of 30 ton FYM + Rhizobium + Rhodotorula. The increases in pods number/plant ranged between 25% and 44% over the positive control owing to the applied bio-organic treatments produced results for seeds nutrient content were similar to that obtained with the positive control without significant differences especially for P content.

Key word: Biofertilizers · bio-organic farming · farmyard manure · forage yield · Guar · seed yield and seeds nutrient content

INTRODUCTION

Guar or cluster bean (*Cyamopsis tetragonoloba*, (L.) taub) is a drought tolerant annual legume grown principally in India and Pakistan. Also, guar is cultivated in USA, Australia and Africa but in small areas. It can be eaten green like snap bean, feed to cattle or used as green manure [1].

Furthermore, guar beans have a large endosperm that containing gloactomannan gum (guar gum) that form gel in water and used in dairy products(ice cream and as cheese), cold-meat processing, paper sizing, textile industry [2] ore floatation and explosives industry.

Guar is a promising summer forage crop that could be used in Egypt to narrow the gap between the available and required summer forage crops for livestocks feeding especially in grass-legume mixtures to increase dry matter yield, protein percent and gave forage of better quality than pure crops [3].

At the time being, application of bio-organic farming became of great importance for sustainable agriculture to stop deterioration of the agricultural lands and environment, to get yield safer for human beings and animals and to encourage the natural enemies of harmful insects and soil born diseases [4].

In comparison with the recommended doses of NPK, application of bio-organic farming increased grain and biological yields of tritical [5]. Gomma *et al.* [6] stated that application of bio-organic farming in vetch overcame the recommended doses of NPK treatment for nodules number and for the majority of tested growth parameters. Khattab and Gomaa [7] reported that further, application of bio-organic treatments increased N-uptake.

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The work within hand was planned to investigate the impact of bio-organic farming application on forage yield, yield and its components and seed content of nitrogen, phosphorus and potassium.

MATERIALS AND METHODS

The present investigation was carried out during the two successive seasons of 2003 and 2004 in newly cultivated lands under sandy soil conditions at the New Salheyia Region, Sharkia Governorate to investigate the response of guar (*Cyamopsis tetragonoloba*, (L.) taub) to the bio-organic farming system.Three rates farmyard manure (FYM) namely 10, 20 and 30 ton/fed. were applied in combination with two types of biofertilizers i.e. Rhizobium and/or soil yeast *(Rhodotorula glutinis)* that applied at rate of 40 L/fed. [7]. The experiment included 6 bio-organic treatments and 2 positive control treatments to compare with as follows:

- Positive control(the recommended doses $N_{20}P_{31}K_{24}$)
- Positive control + Rhizobium (Rh.)
- 10 ton FYM/fed. + Rh.
- 10 ton FYM/fed. + Rh.+ Yeast
- 20 ton FYM/fed. + Rh.
- 20 ton FYM/fed. + Rh.+ Yeast
- 30 ton FYM/fed. + Rh
- 30 ton FYM/fed. + Rh.+ Yeast

The experimental soil (0-30 depth) was analyzed according to the method described by Chapman and Pratt [8]. Soil texture was sandy and having the characteristics: sand 90.4%, pH 8.0, organic matter 0.51%, available N40.0 ppm, available P 12.8 ppm, available K 137 ppm. Farmyard manure contains organic matter 39.66%, organic carbon 23.0%, C:N ratio 12.92 pH 7.8, E.C. mm hos cm^{-3} 2.1, total N 1.78%, available P 88 ppm and available K 84 ppm.

The various rates farmyard manure were applied to soil then irrigated. Ten days after manuring, guar seeds c.v Giza 2 were sown in each plots in the first week of June 2003 and 2004 seasons. The experimental plot was 10.5 m^2 (5 ridges, 3.5in length and 0.60 m in width). Biofertilizertion was applied immediately after sowing then covered with a thin layer same sand soil.

Three weeks after sowing, the plants were thinned to two plants per hill. NPK used in the form of ammonium nitrate (33% N) at the rate of 20 kg N $fed.^{-1}$, calcium super phosphate (15.5% P_2O_5) at the rate of 31 kg P $fed.^{-1}$ and potassium sulphate (48% K_2O) at the rate of 24 kg k $fed.^{-1}$.

Superphosphate and potassium sulphate were added to the positive control treatments during soil preparation, while ammonium nitrate was applied after thinning. The experimental design was a Randomized Complete Block Design in six replicates. After 45 days, the sample was taken for nodulation testing. At 60 days old, three replicates for evaluating the forage fresh yield (kg $fed.^{-1}$). Then sub sample of 1 m^2 was dried in oven to determine dry matter% and protein% according to Chapman and Pratt [8].

The rest three replicates were left for determining guar yield and yield components (120 days of cultivation).

At harvest, ten plants of the middle two rows were taken randomly to determine the yield components as follows: plant height (cm), number of pods/plant, number of seeds/pod, number of seeds/plant and seed index (100 seed weight).

Whole plot was harvested to determine seed yield and biological yield/fed. Harvest index calculated by dividing seed yield/biological yield. The seed nitrogen, phosphorus and potassium contents were determined according to Chapman and Pratt [8].

The combined analysis of data the two seasons was conducted and means of various treatments were compared together using LSD at 5% significant level [9].

RESULTS AND DISCUSSION

1 - Effect of chemical fertilization and farmyard manure

Nodulation and forage yield: The impact of various tested treatments on nodulation, forage fresh yield per fed dry matter % and its content of protein (60 days old) against the positive control (NPK recommended dose) was demonstrated in Table 1. As regards nodules number per plant, it is ranged from 4 to 7 nodules/plant being the highest due to the application of 30 ton FYM $fed.^{-1}$.

For forage fresh yield per fed the differences recorded among fertilization treatments were insensible. Regarding the dry matter %, it was found that the treatment of 30 ton $fed.^{-1}$ of farmyard manure registered the lowest value in with either the other tested treatments or positive control that produced the highest value of dry matter %.

Also data in Table 1 show that addition of recommended dose of chemical fertilizer N20, P31, K24 + Rh. gave the highest protein %, but 10 ton $fed.^{-1}$ of farmyard manure gave the lowest value of protein %.

Yield and its components: Data presented in Table 1 clear that application of 10, 20, 30 ton $fed.^{-1}$ of farmyard manure produced plant height significantly overcame that

Table 1: Effect of chemical fertilizer and farmyard manure on nodulation, forage yield,seed yield and its components and seeds nutrient content

Attributes						Number of									
		Forage yield at 60 days old					Seeds			Seed	Bio		Seed nutreint		
	Nodules				Plant										
	No./	F W	Dry	Protein	height	pods			Seed	yield	yield	Harvest			
Treatment	plant	kg fed.$^{-1}$	matter%	%	(cm)	/plant	/pod	/plant	index	kg fed.$^{-1}$	kg fed.$^{-1}$	index	N (%)	P (%)	K (%)
Positive control (100%NPK)	4	1282	20.40	16.91	100	16.00	5.67	88	4.05	457	2357	0.194	4.16	0.56	1.08
Positive control +R h.	5	1303	20.13	17.06	107	17.70	6.00	103	4.15	472	2397	0.197	4.06	0.56	1.30
10 Ton/fed.	5	1245	18.38	16.47	113	20.40	7.17	140	4.02	550	2823	0.195	3.85	0.55	1.09
20 Ton/fed.	5	1298	16.22	16.69	126	22.20	8.17	178	3.99	592	3026	0.196	3.95	0.56	1.13
30 Ton/fed.	7	1287	14.85	16.66	131	22.00	7.00	155	3.85	560	3083	0.181	4.25	0.56	1.15
LSD at 5%	-	NS	0.28	0.18	7.84	2.66	1.50	7.11	NS	58	405	0.006	0.25	NS	NS

Table 2: Effect of chemical fertilizer and biofertilization on nodulation, forage yield, seed yield and its components and seeds nutrient content

Attributes						Number of									
		Forage yield at 60 days old					Seeds			Seed	Bio		Seed nutreint		
	Nodules				Plant										
	No./	F W	Dry	Protein	height	pods			Seed	yield	yield	Harvest			
Treatment	plant	kg fed.$^{-1}$	matter %	%	cm	/plant	/pod	/plant	index	kg fed.$^{-1}$	kg fed.$^{-1}$	index	N (%)	P (%)	K (%)
Positive control (100%NPK)	4	1282	20.40	16.91	100	16.00	5.67	88	4.05	457	2357	0.194	4.16	0.56	1.08
Positive control +R h.	5	1303	20.13	17.06	107	17.70	6.00	103	4.15	472	2397	0.197	4.06	0.56	1.30
Rhizobium	5	1267	16.35	16.37	120	21.57	7.45	157	4.02	551	2896	0.190	3.90	0.56	1.11
Rhizobium + yeast	6	1286	16.61	16.83	126	21.50	7.44	158	3.88	584	3068	0.190	4.13	0.56	1.13
LSD at 5%	-	NS	0.22	0.14	6.40	1.73	1.22	5.81	NS	47	331	NS	0.20	NS	NS

obtained with the positive control, inclusion of biofertilizers to the positive control caused insignificant increase in plant height when compared to the positive control (NPK recommended dose) as such.

Besides, the three applied rates of farmyard manure induced significant variation for the number of pods per plant in comparison with positive control (NPK recommended dose). The same trend was found also for the number of seeds per pod and number of seeds per plant. Table 1 also indicates that utilization of farmyard manure significantly increased these yield attributes parameter over the positive control.

The heaviest seed yield per fed recorded by 20 ton fed.$^{-1}$ of farmyard manure while treatment of 30 ton fed.$^{-1}$ of farmyard manure gave the best biological yield per fed. Moreover, the various tested treatments produced values for each of seed index, P-content and K-content of seed were comparable to the positive control without significant differences.

Concerning the harvest index, it was found that the diverse treatments (expect the rate of 30 ton fed^{-1} of farmyard manure) induced values were not insignificant when compared to the positive control (NPK recommended dose). No significant variations were observed between the different treatments regarding seed nitrogen content expect the rate of 10 ton fed^{-1} of farmyard manure that recorded the least value.

2 - Effect of chemical and Bio-fertilization

Nodulation and forage yield: Table 2 shows the influence of various fertilization sources on nodulation, forage fresh yield per fed, dry matter % and its content of protein. As to nodulation, the combined biofertilization with Rhizobium and yeast the highest number of nodules the reached 6 per plant, while the nodules number that recorded with the positive control reached 4 per plant.

As concerns the forage fresh yield per fed at 60 days old, little differences was recorded among the tested treatments where the highest value for the parameter was obtained due to the application full dose of NPK supplemental with the biofertilizaters.

The positive control (NPK recommended dose) either as such or supplemental with the biofertilizaters induced the highest values of dry matter. The same trend was found for seed content of protein.

Yield and its components: Table 2 shows the effect of various fertilization sources on yield and yield components. As for each plant height and number of seeds per plant, Table 2 indicates that the tested

Table 3: Effect of chemical fertilizer, farmyard manure and biofertilization on nodulation, forage yield,seed yield and its components and seeds

Attributes						Number of									
		Forage yield at 60 days old													
	Nodules				Plant		Seeds			Seed	Bio		Seed nutreint		
	No/	F W	Dry	Protein	height	pods			Seed	yield	yield	Harvest			
Treatment	plant	kg fed.$^{-1}$	matter%	%	cm	/plant	/pod	/plant	index	kg fed.$^{-1}$	kg fed.$^{-1}$	index	N (%)	P (%)	K (%)
Positive control (100%NPK)	4	1282	20.40	16.91	100	16.00	5.67	88	4.05	457	2357	0.194	4.16	0.56	1.08
Positive control + Rh.	5	1303	20.13	17.06	107	17.70	6.00	103	4.15	472	2397	0.197	4.06	0.56	1.30
10 Ton/fed. + Rh.	4	1235	18.26	16.25	108	20.00	7.00	134	4.14	547	2809	0.195	3.80	0.55	1.08
10 Ton/fed. + Rh. + Yeast	5	1255	18.50	16.68	118	20.80	7.33	145	3.89	553	2836	0.195	3.90	0.56	1.10
20 Ton/fed. + Rh.	5	1291	16.13	16.37	125	21.70	7.67	163	4.11	554	2883	0.192	3.90	0.56	1.12
20 Ton/fed. + Rh. + Yeast	4	1305	16.30	17.00	126	22.70	8.67	193	3.87	630	3169	0.199	4.00	0.56	1.13
30 Ton/fed. + Rh.	6	1276	14.66	16.50	128	23.00	7.67	173	3.81	552	2997	0.184	4.00	0.56	1.14
30 Ton/fed. + Rh. + Yeast	8	1297	15.03	16.81	133	21.00	6.33	137	3.89	568	3199	0.178	4.50	0.57	1.16
LSD at 5%	-	NS	0.40	0.25	11.08	2.99	2.12	10.06	NS	82	573	0.009	0.26	NS	0.07

fertilization sources produced increases were significant when compared to the positive control (NPK recommended dose).

For the number of seeds per pod, seed yield per fed and biological yield per fed., the biofertilization treatments of Rhizobium or Rhizobium combined with the soil yeast significantly overcame the positive control (NPK recommended dose). Moreover, the bio-fertilization with either Rhizobium as such or when accompanied with the soil yeast, *Rhodotorula glutinis,* augmented the number of pods per plant where the percentages of increases ranged from 11 to 35%. These increases could be attributed to the promotive effect of applied bio-fertilizers on plant growth. The obtained results were found to be on the same line with those obtained by Gaballah and Gomaa [10] and Mohamed and Gomaa [11].

Further, the various tested treatments induced comparable results to the positive control concerning each of seed index, harvest index, seed P-content and seed K-content. As to the seed N-content, the bio-treatment of Rhizobium + yeast induced a matchable result to the positive control.

3 - Effect of chemical, farmyard manure and Bio-fertilization

Nodulation and forage yield: The interaction between farmyard manure, biofertilizers and applied rates of farmyard manure**,** Table 3 shows that the increases in root nodules formation ranged from 25 to 100% being the highest with the bio-organic treatment of 30 ton FYM/fed. + Rhizobium + Yeast.

The combined effect of organic and bio-treatments presented in Table 3, it is clear that guar plants treated by 20 ton FYM/fed. + Rhizobium + yeast produced the greatest forage fresh yield per fed followed by NPK recommended dose + Rhizobium and 30 ton FYM/fed. +Rhizobium + yeast.

Due to dry matter %, the positive control (NPK recommended dose) came in the first order followed by NPK recommended dose + Rhizobium and 10 ton FYM/fed. + Rhizobium + yeast in the third order.

Treatment of NPK recommended dose + Rhizobium gave the highest protein % followed by 20 ton FYM/fed. + Rhizobium + yeast and 30 ton FYM/fed.+ Rhizobium + yeast

Yield and its components: Table 3 shows the impact of the tri interaction between farmyard manure, biofertilizers and applied rates of farmyard manure at yield and its components. It is obvious that the bio-treatments consists of 20 or 30 tons of farmyard manure and tested biofertilizers significantly augmented each of plant height, number of pods/plant, number of seeds/plant, seed yield/fed and biological yield/fed.

Besides, the results produced for seed index was not significant in comparison with positive control. Moreover, the most tested bio-organic treatments induced comparable results to the positive control for each of number seeds per pod and harvest index.

Concerning seeds nutrient content, the highest values for nitrogen and phosphorus contents were obtained to the application of 30 ton fed.$^{-1}$ farmyard manure accompanied by Rhizobium and Yeast. For potassium content, the tested bio-organic treatments induced similar results to the positive control without significant differences, beside each of full of doses of

NPK supplemented with Rhizobium only treatment significantly augmented K-content over the positive control.

These results are in harmony with those obtained by Gomaa *et al.* [4] and El Kramany *et al.* [12], Mahalakshmipria and Vijayalakshmi [13].

Bio-organic treatments recorded the highest increase (36%) over the positive control for biological yield per fed. With regard to the number of pods per plant, the increases over the positive control ranged between 25% and 44% due to the application various tested bio-organic treatments, while the increase for seed yield (kg fed.$^{-1}$) ranged from 20% to 38%. Gomaa *et al.* [6]; Abdel-Wahab and Said [14] and Gomaa and Khattab [15] stated that the application bio-organic farming increased growth and yield of vitch, faba bean and roselle light and dark color varieties respectively.

CONCLUSIONS

The results obtained indicated that guar plant can be grown successfully in newly cultivated sandy soil as summer legume crop. It have double use (forage and seeds) one cut at 60 days ranged between (1282-1305 kg fed.$^{-1}$), dry matter (14.66-20.40%) and (16.25-17.06%) protein in forage.

It can produce legume forage at 60 days with utilize bio organic fertilizers. It can be used alone or mixed with maize or sorghum for animal feeding particularly in the summer season in Egypt to reduce the gab in summer forage.

It can be produce (457-630 kg fed.$^{-1}$) seeds contain (4.06-4.50N %) and (2357-3199 kg fed.$^{-1}$) biological yield per fed when cultivate to seed yield.

The combined effect of bio and organic fertilizers can be effective tool in reducing chemical fertilizers especially in legume crops as guar without reducing seed and biological yield per fed.

Finally, it could be concluded that, in such trial soil (sandy) in Egypt combination between bio-organic fertilizers to replacement chemical fertilizers, decrease cost ratio and get yield safer.

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