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COMPLEMENTATION OF DIAZOTROPH INOCULATION AND ORGANIC AMENDMENT TO AMELIORATE BEAN PRODUCTION IN DRIP IRRIGATED ENVIRONMENTS

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ABSTRACT

A field trial was conducted in sandy soils of Ferdan region, Ismailia, under drip irrigation system (low water supply using GR type 4.0 L./hr with about15556 drippers/fed.), such drippers discharge about 62.22 m^3 / fed.). This is to monitor the role of various combinations between diazotroph inoculation and organic manuring on N_2-fixation, growth, vegetable and seed yields of bean plant(*Phaseolus vulgaris*).

Two types of N_2-fixing bacteria were used, symbiotic (*Rhizobium leguminosarum* bv. *Phaseolus*) and associative (a composite inoculum of five different candidates). Different ratios of two kinds of organic fertilizers, farm yard and poultry manures were used and 33 different treatments assuming from different combination 0f the organic fertilizers and the Diazotrophs inoculation were tested.

Results of 50- day old plants indicated that the superior treatment was the mixture of N_2-fixing bacteria, combined with starter dose of nitrogen (20kgN/fed) simultaneously with organic amendment of 33.3% farm yard manure and 66.7% poultry manure (OF_3). This treatment supported the highest nodulation, growth and N-content compared to other ones. At Harvest, combination of organic manures in presence of diazotroph inoculation and 20 kg N/fed produce best vegetable yield at 80 and 100 day growth period. Seed yield of bean plants showed no significant differences between plants received 60 kg N/fed. and those inoculated but supplied with 20 kg N/fed and fertilized with organic materials.

In conclusion, it is preferable to use a mixture of N_2-fixing (rhizobia + associative) inoculants with organic fertilizers (compost) combined with starter dose of nitrogen (20 kg N/fed) to maximize bean growth, vegetable and seed yields specially under drip irrigation system with low amount of water supply in sandy soil.

Keywords: Bean, *Rhizobium leguminosarum* bv. *Phaseolus*, Associative N_2-fixers, Farm Yard Manure, Poultry Manure, Sandy soil, Drip irrigation.

INTRODUCTION

In Egypt, during the last five decades, both soil fertility and productivity have declined due to 1) use of chemically synthesized fertilizers which largely replaced organic manuring, 2) extensive tillage and cultivation and 3) residue burning. The increased application of inorganic fertilizers especially N-fertilizer causes a sharp escalation of production cost and also, the reason for environmental pollution. recently, the safe agriculture is one of the main attitudes of the world (El-Kouny, 1999). Using organic fertilizers may decrease the use of mineral fertilizers, consequently they ensure clean agriculture products. In the meantime, addition of organic fertilizers in sandy soil improves soil structure. This helps the plant to have a good root development by improving soil aeration, which leads to high yield (Singer *et al.*, 1998). The

organic materials are a main sources of nitrogen, 50 – 60% ; phosphorus, 80%; sulpher and high content of boron and molybdenum (Bohn *et al.*, 1985). Therefore, great efforts are being made on composting organic wastes to produce organic manures required to modify soil structure, increase water holding capacity, nutrients uptake and hence raise Egyptian soil productivity (Mahmoud *et al.*, 1989). Also, it is necessary to add the organic fertilizers to improve the biological properties of the newly reclaimed sandy soils (Bhon *et al.*, 1985). Composts used for soil amendment or in container media may protect plants from diseases caused by soil borne root pathogens (Marcos *et al.*, 1995). Nitrogen fixing microorganisms are important component for sustainable agricultural systems. The use of diazotrophic bacteria and/or symbiotic bacteria have bean evaluated by many investigators with different crops. (Dasilva, *et al* 1993; AboTaleb, 1998; Mekhemar and Al-Kahal, 2002).

Leguminous plants especially bean (*Phaseolus vulgaris*) are characterized by high nutrition value and contain exceptional quantities of nitrogen.

Bean protein contains different essential amino acids plus high concentrations of niacin, lysine and folic acid. Moreover, bean plants are able to fix 20 – 60 kg N/ha in tropical environments (Dasilva *et al*, 1993). In Egypt, bean are widely consumed as vegetable and dry bean.

The aim of the present work is to monitor nodulation, biological nitrogen fixation, and growth as well as vegetable and dry yields of bean plants as affected by inoculation with different diazotrophic bacteria combined with organic manuring under low water supply by drip-irrigation system in sandy soil.

MATERIALS AND METHODS

A field experiment was conducted in Ferdan region, Ismailia governorate to study the effect of inoculation with various diazotrophic bacteria, rhizobia and application of two type composts compound in mixture (Farm yared manure and poultry manure) as organic fertilizers on nodulation, biological nitrogen fixation, growth and vegetable & dry yields of beans plants under drip irrigation system.

1- Soil

Soil sample was collected from Ismailia fields and analyzed for physico-chemical properties according to Black *et al.* 1965. The soil had sandy texture and characterized by: sand, 93.2%; silt, 5.6%; clay, 0.99%; EC, 0.43dsm^{-1} ; organic matter, 0.17% total nitrogen, 18.5 ppm and pH of 7.8.

2- Plant material

Bean seeds (*Phaseolus vulgaris*) of cultivar Exera, characterized by high productivity were planted with two seeds in hills, 30 cm in between at seed rate of 35 kg/fed.

3- Diazotrophs

Two types of N_2-fixing bacteria were used. The first is peat-based inoculum of *R. leguminosarum* bv. *phaseolus* (strains, ARC 305 and Forgen 1899). The inoculum was prepared by Biofertilizers Production Unit (BPU), Soils, Water and Environment Research Institute, Agriculture Research

Center, Giza Egypt. The second is a peat-based composite inoculum contains *Azospirillum brasilens*, *Azotobacter chroococcum*, *Bacillus polymyxa*, *Kelebciella pneumoniae* and *Pseudomonas putida* and kindly provided by The Environmental Studies and Research Unit (ESRU), Faculty of Agriculture, Cairo University. The inocula were used at a rate of 4 g inoculants per 100 g seeds.

4- Organic fertilizers(OF)

Two kinds of organic fertilizers were used in the present study, farm yard manure and poultry manure. Each type of compost was incubated in hip for 120 days where moisture content was maintained at 60% WHC. The hip was mixed and turned every two weeks for aeration. Different compost samples were collected from each one and mixed thoroughly to give one homogenous sample. Physical and chemical properties (Table 1) of samples were determined. The organic fertilizers (OF) were added two weeks prior to planting at a rate of 14.4 kg/plot representing 10 ton/fed. The following seven different mixtures of both fertilizers were used.

	Mixture ratio (%)						
Organic Fertilizers	OF_1	OF_2	OF_3	OF_4	OF_5	OF_6	OF_7
Farm yard manure	0.0	16.7	33.3	50.0	66.7	83.3	100
Poultry manure	100	83.3	66.7	50.0	33.3	16.7	0.0

Table 1: Main characteristics of the used organic manures.

Properties		Farm yard manure	Poultry manure
Moisture content	(%)	40	18
Organic carbon	(%)	24.4	27.4
Total nitrogen	(%)	1.2	1.3
C/N ratio		19.8	20.9
Available nitrogen	(ppm)	502.2	1321.4
Available phosphorus	(ppm)	1244.4	823.2
Available potassium	(ppm)	491.8	617.5
EC	(dsm^{-1})	0.23	0.66
pH		7.1	7.5

5- Mineral fertilizers (MF)

During seedbed preparation, superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) were added at rates of 100 and 50 kg/fed, respectively. Nitrogen fertilizer was added at two level 20 and 60 kg N/fed as ammonium sulphate (20.5% N) after two and four weeks of planting.

6- Irrigation system

Each irrigation was carried out for 90 minutes, (low water supply compared with the normal one which use 120 minutes) where drippers of GR type were used. Such dripper discharges 4.0 L./hr. Number of the drippers / fed. was 15556. The previous drippers discharge about 62.22 m^3 / fed. per one hour.

7- Experimental design

33 different treatments assuming from different combination 0f Organic fertilizers and Diazotrophs inoculation were tested in Randomized complete

block design with eight replications . The plot size was 6 m^2 (3m X 2m). Statistical analysis was don use of L.S.D. method at 5 % level of significance according to Snedecor and Cochran (1981).

The following 33 treatments were allocated

1- Control (Untreated plants)
2- Uninoculated, recommended 60 kgN/fed.
3- Rhizobium-inoculated (RI) + 20 kgN/fed.
4- Composite, inoculated (CI) + 20 kgN/fed.
5- Mixture inoculants (RI + CI) + 20 kgN/fed.
6 to12- Uninoculated+ 20 kgN/fed + Organic fertilizer O F_1, O F_2, O F_3, O F_4, OF_5, OF_6 or OF_7.
13 to19- Inoculated (RI) +20 kgN/fed + Organic fertilizer OF_1, OF_2, OF_3, OF_4, OF_5, OF_6 or OF_7.
20 to 26- Inoculated (CI) + 20 kgN/fed + Organic fertilizer OF_1, OF_2, OF_3, OF_4, OF_5, OF_6 or OF_7.
27 to33- Inoculated (RI + CI) + 20 kgN/fed + Organic fertilizer OF_1, OF_2, OF_3, OF_4, OF_5, OF_6 or OF_7.

RESULTS AND DISCUSSION

Growth stage:-

A) Nodulation :-

Data presented in Table 2 showed that no nodules were formed on roots of uninoculated bean plants or those inoculated with composite inoculum of associative diazotrophs. It means that the experimental site was devoid from bean specific rhizobia. Rhizobia inoculation as such or in combination with associative diazotrophs under 20 kg N/fed possessed about 7 or 9 nodules/plant, respectively, having a dry weight of nodules 11 or 14 mg nodule/plant. Irrespective of organic fertilizers, Fig 1, demonstrates that composite inoculum stimulated the rhizobia for legume nodulation. It is clear that plant inoculanted with mixed population of associative N_2-fixers and rhizobia developed a bigger number of nodules with higher dry weights compared to these inoculated with risobium alone. These data are in agreement with Srinivaon *et al.* (1996) and (1997) who reported that inoculated bean plants with specific rhizobia in presence of associative N_2-fixers induced root hair, proliferation and improved nodulation process. They suggested that the stimulating effect was probably due to the production of some plant growth promoting substances such as IAA which change the root morphology, i.e. root hair shape or density. Significant variation in nodule formation was recorded among the various treatments of compost mixture combined with rhizobia inoculation. In the absence of composite inoculum, the highest nodule number 17 and 18 /plant were recorded in the application of 16.7 and 100% farm yard manure (OF_2 andOF_7), respectively. The same trend was found in nodule dry weight and scored 36 and 30 mg /plant in the same order. In presence of composite inoculum, the highest nodule numbers of 28, 30 and 26 /plant were recorded with application of 16.7, 33.3 and 100% farm yard manure (OF_2, OF_3 and OF_7), respectively. The nodule dry weights recorded in same treatments were 51, 52 and 49 mg /plant in the same order. These results are in agreement El-Khatib (2000) reported that application of

On the other hand, acetylene reduction activity (ARA) for different treatments was estimated and the high rate was obtained under fertility condition. Generally, the highest value of ARA (276.5 nmoles C_2H_4/plant/hr.) was recorded with inoculation with specific rhizobia combined with application of 16.7 % farm yard manure (OF_2) in absence of associative composite inoculum. However, the highest value was 265.0 nmoles C_2H_4/plant/hr. in the treatment of Rhizobium inoculation and composite inoculum combined with application of 16.7 % farm yard manure (OF_2).

Table (2): Nodulation, acetylene reducing activity (ARA), growth and N-content of bean plants as affected by diazotroph inoculation incompination with organic fertilizers at 50-day growth period.

Treatments				Nodulation per plant		ARA nmole C_2H_4/plants/hr		Shoot(per plant)	
OF	RI	CI	NF	No.	DW (mg)	1 hr.	24 hr.	DW (g)	N-content (mg)
-	-	-	0	0	0	0	0	1.12	22.41
-	-	-	60	0	0	0	0	1.53	41.54
-	+	-	20	7	11	18.4	0	1.39	38.57
-	-	+	20	0	0	0	0	1.35	35.55
-	+	+	20	9	14	11.5	159.4	1.41	40.99
OF_1	-	-	20	0	0	0	0	1.27	39.91
OF_2	-	-	20	0	0	0	0	1.29	38.55
OF_3	-	-	20	0	0	0	0	1.33	43.61
OF_4	-	-	20	0	0	0	0	1.26	32.30
OF_5	-	-	20	0	0	0	0	1.28	42.35
OF_6	-	-	20	0	0	0	0	1.53	38.82
OF_7	-	-	20	0	0	0	0	1.47	34.48
OF_1	+	-	20	11	18	0	11.5	1.47	38.12
OF_2	+	-	20	17	36	117.5	276.5	1.42	38.11
OF_3	+	-	20	14	27	0	0	1.51	39.78
OF_4	+	-	20	15	27	0	69.1	1.49	41.54
OF_5	+	-	20	8	18	9.8	135.9	1.56	44.75
OF_6	+	-	20	13	20	24.8	85.2	1.43	42.89
OF_7	+	-	20	18	30	0	0	1.56	39.91
OF_1	-	+	20	0	0	0	0	1.48	36.71
OF_2	-	+	20	0	0	0	0	1.46	32.35
OF_3	-	+	20	0	0	0	0	1.31	35.57
OF_4	-	+	20	0	0	0	0	1.49	40.45
OF_5	-	+	20	0	0	0	0	1.52	38.22
OF_6	-	+	20	0	0	0	0	1.48	37.22
OF_7	-	+	20	0	0	0	0	1.39	34.81
OF_1	+	+	20	15	29	29.9	103.7	1.56	38.91
OF_2	+	+	20	28	51	51.8	265.0	1.49	44.93
OF_3	+	+	20	30	52	23.1	80.6	1.57	48.20
OF_4	+	+	20	18	37	2.9	0	1.48	45.91
OF_5	+	+	20	20	41	5.8	39.2	1.53	39.81
OF_6	+	+	20	21	41	8.9	43.7	1.54	43.88
OF_7	+	+	20	26	49	35.9	127.1	1.51	45.11
LSD		0.05		4	5.6	-	-	0.07	4.17

OF : Organic fertilization.RI : Rhizobial inoculation.
CI : Associative coposite inoculation.NF : Nitrogen fertilization.

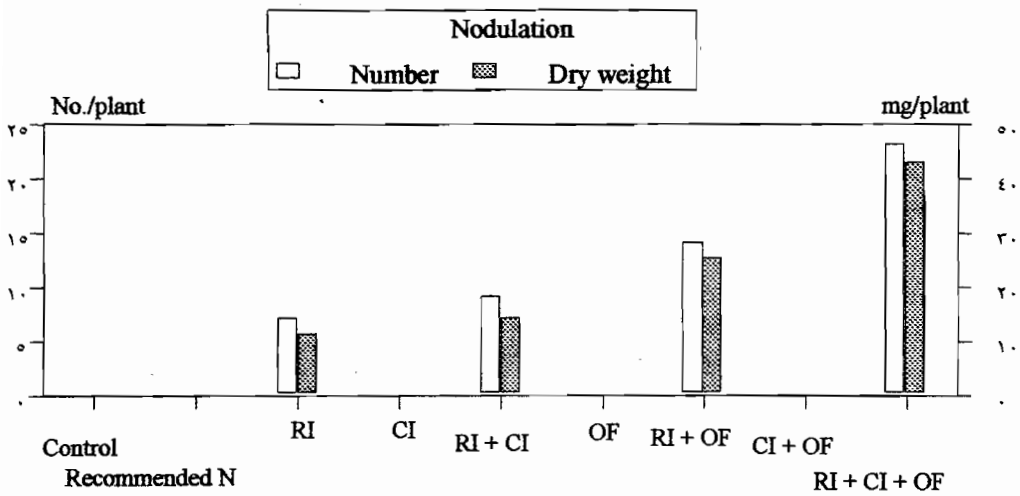

Fig 1: Effect of *Rhizobium* and/or composite inoculum of associative diazotrophs combined with organic fertilization on nodulation of bean plants grown in sandy soil.

B) Plant dry weight and N-content :

Data given in Table 2 showed that significant differences were found among the various treatments. Untreated plant had the lowest shoot dry weight (1.12 g/plant) and shoot N-content (22.41 mg/plant). Application of N-fertilizer (60 kg N/fed) scored higher plant biomass (1.54 g/plant) and N-content (41.54 mg/plant). However, inoculation with specific rhizobia and/or composite inoculum of associative diazotrophs in presence of 20 kg N/fed. did improve plant biomass and N-content compared with untreated ones.

Application of organic fertilizer at different mixing ratios gave higher increases in the two above-mentioned plant parameters. The highest values (1.57g/plant and 48.20 mg/plant) were recorded for treatment, received 33.3 % farm yard manure (OF_3) and inoculated with rhizobia (RI) and associative diazotrophs (CI). Generally, Fig 2 illustrates that rhizobia and composite inoculants (RI + CI) combined with organic fertilizer (OF) + 20 kg N/fed had no effect compared with full dose of N-fertilizer. This means that the extreme condition prevailing in the experimental site of Ismailia, sandy soils necessitates the introduction of various groups of rhizosphereic microorganism (RMO) particularly those of N_2-fixing ability with using organic fertilizer. In this respect, these results are in agreement with these obtained by Abo-Taleb, (1991); Mekhmar and El-Kahal, 2002).Harvest stage:-

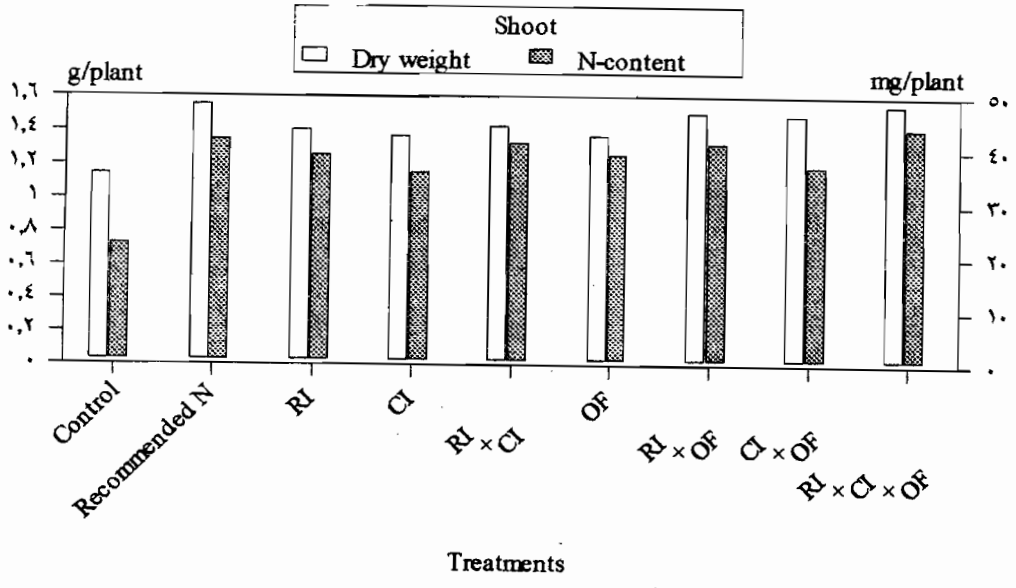

Fig 2: Effect of *Rhizobium* and/or composite inoculum of associative diazotrophs combined with organic fertilization on growth and N-content of bean plants.

A) Vegetable yield :-

Vegetable yield of bean was taken twice at 80 and 100 days after planting (DAP). Data recorded in Table 3 showed that untreated plant had the lowest values (0.159 and 0.128 kg/plot). Inoculation with composite inoculum of associative N_2-fixers and 20 kg N/fed gave higher yield but not significantly differed with control treatment. Rhizobia inoculation (RI) and 20 kg N/fed as such or combined with (CI) led to significant increases plants received the recommended dose of nitrogen (60 kg N/fed) recorded the highest values of 2.69 and 2.81 kg/plot at 80 and 100 DAP, respectively. Generally, application of different compost ratios of the two type of organic fertilizers and diazotrophs (RI and CI) in the presence of 20 kg N/fed had no great differences in vegetable yield compared with treatment received the 60 kg N/fed. In contract, at 100 DAP, Treatments supplied with OF_3, OF_5, OF_6 and OF_7 recorded higher values of 2.91, 2.99, 2.98 and 2.90 kg vegetable pod/plot, respectively, compared to plants received the 60 kg N/fed (2.81 kg/plot). These data are in agreement with those obtained by Morcos *et al.* (1995), Zaghloul (2002), Al-Kahal (2002)and Badran (2002) who reported that growth characteristics and yield components were significantly increased with organic fertilizer application in combination with different biofertilizers used.

B) Biological, straw and seed yield:-

Biological, straw and seed yields are recorded in Table 3 and illustrated in Fig 3. Results were significantly affected by inoculation with (RI) and/or (CI) treatments in combination with organic fertilizer application compared to untreated ones. However, plants received 60 kg N/fed gave the highest yield parameters among others.

Plants supplemented with organic fertilizers combined with N_2-fixing bacteria and received 20 kg N/fed, resulted in no significant increases in seed yield (0.519 kg/plot) compared with plants received the recommended dose of nitrogen 60 kg N/fed (0.611 kg/fed).

Table 3: Vegetable and dry yield of bean plants as affected by +inoculation with *Rhizobium* and associative N_2-fixing bacteria combination with organic fertilizers at 50 days old plant.

Treatments				Vegetable yield (kg/plot)		Vegetable yield Ton/fed	Dry yield (kg/plot)			Seed yield (kg/fed.)
OF	RI	CI	NF kg/fed	80 DAP	100 DAP		Biological yield	Straw yield	Seed yield	
-	-	-	0	0.159	0.128	0.208	0.245	0.204	0.041	28.7
-	-	-	60	2.690	2.810	3.850	2.173	1.556	0.611	427.7
-	+	-	20	0.540	0.580	0.784	0.831	0.762	0.169	118.3
-	-	+	20	0.470	0.510	0.686	0.779	00628	0.151	105.7
-	+	+	20	0.630	0.570	0.840	0.861	0.787	0.174	121.8
OF_1	-	-	20	1.330	1.410	1.918	1.921	1.504	0.417	291.9
OF_2	-	-	20	1.170	1.220	1.673	1.586	1.136	0.450	315.0
OF_3	-	-	20	1.210	1.370	1.806	1.702	1.219	0.483	338.1
OF_4	-	-	20	1.190	1.390	1.806	1.596	1.229	0.367	256.9
OF_5	-	-	20	1.200	1.410	1.827	1.551	1.098	0.453	317.1
OF_6	-	-	20	1.270	1.370	1.848	1.621	1.181	0.440	308.0
OF_7	-	-	20	1.210	1.400	1.827	1.526	1.093	0.433	303.1
OF_1	+	-	20	2.170	2.440	3.227	1.762	1.262	0.500	350.0
OF_2	+	-	20	2.040	2.370	3.059	1.968	1.401	0.567	396.9
OF_3	+	-	20	2.500	2.810	3.717	1.939	1.389	0.550	385.0
OF_4	+	-	20	2.250	2.520	3.339	1.702	1.219	0.483	338.1
OF_5	+	-	20	1.830	2.110	2.758	1.738	1.245	0.493	345.1
OF_6	+	-	20	2.830	2.940	4.039	1.822	1.305	0.519	301.9
OF_7	+	-	20	1.930	2.730	3.262	1.720	1.232	0.488	341.9
OF_1	-	+	20	2.00	2.500	3.150	1.293	0.926	0.367	251.9
OF_2	-	+	20	1.670	1.970	2.548	1.469	1.052	0.417	291.9
OF_3	-	+	20	1.690	2.110	2.660	1.349	0.966	0.383	268.1
OF_4	-	+	20	1.710	1.870	2.506	1.343	0.963	0.380	266.0
OF_5	-	+	20	1.830	2.140	2.779	1.695	1.214	0.481	336.7
OF_6	-	+	20	2.100	2.510	3.227	1.762	1.262	0.500	350.0
OF_7	-	+	20	1.960	2.370	3.031	1.738	1.245	0.493	345.1
OF_1	+	+	20	2.170	2.500	3.269	1.879	1.346	0.533	373.1
OF_2	+	+	20	2.100	2.470	3.199	1.693	1.193	0.504	350.0
OF_3	+	+	20	2.750	2.910	3.962	1.979	1.446	0.533	373.1
OF_4	+	+	20	2.630	2.710	3.738	1.801	1.290	0.511	357.7
OF_5	+	+	20	2.610	2.990	3.920	1.823	1.305	0.518	362.6
OF_6	+	+	20	2.580	2.980	3.892	1.755	1.257	0.498	348.6
OF_7	+	+	20	2.660	2.900	3.878	1.903	1.343	0.540	378.0
LSD			0.05	0.370	0.510	-	0.338	0.142	0.096	-

Finally, it is concluded that it is preferable to use a mixture of N_2-fixing bacteria (rhizobia + associative) inoculants with organic fertilizers (compost) combined with starter dose of nitrogen (20 kg N/fed) to obtain good growth, vegetable and seed yields of bean plant. It could be reduced the used of heavy nitrogen fertilizers. This is mean that reducing environmental pollution. Using compost in such desert soil specially under low amount of water supply in drip irrigation system increasing both fertility and productivity as a results of improving soil properties.

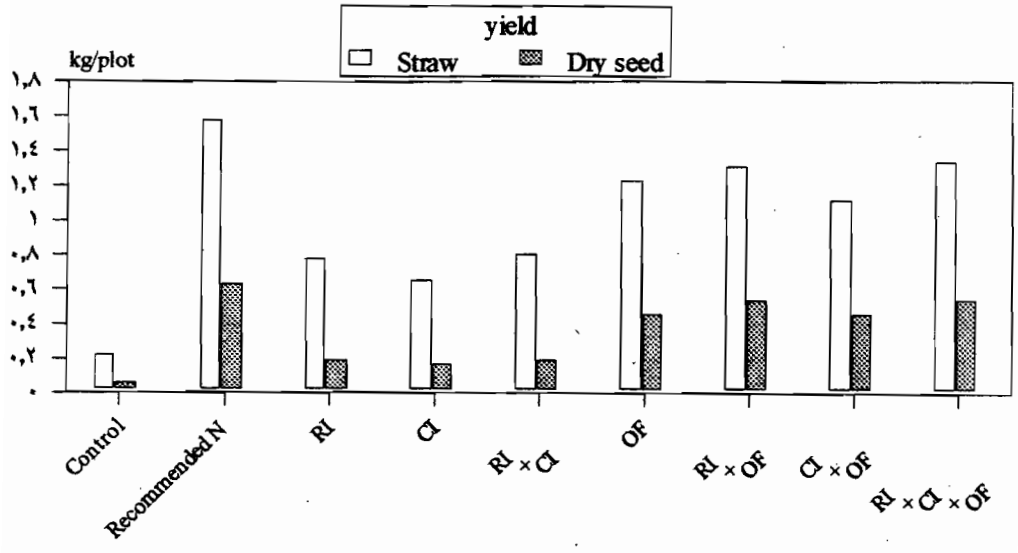

Fig (3): Effect of *Rhizobium* and/or composite inoculum of associative diazotrophs combined with organic fertilization on straw and seed yields.

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التكامل بين التلقيح البكتيرى و التسميد العضوى لتحسين إنتاجيه الفاصـــوليا فـــى الأوساط البيئية تحت ظروف الرى بالتنقيط

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أجريت تجربة حقلية بأرض رملية في منطقة الفردان – محافظة الإسماعيلية - لاختبار مدى كفاءة إستخدام التلقيح البكتيرى والتسميد العضوى على زيادة تثبيت النيتروجين الجوى حيويا والنمو وكـذلك المحصـول الخضـرى والجاف لنباتات الفاصوليا المنزرعة فى الارض الرملية تحت نظام الرى بالتنقيط. (إستخدمت نقاط ال جي أر والتـي تصرفها ٤لتر/ ساعة باجمالي١٥٥٥٦نقاط للفدان و بمعدل ٦٢,٢٢ متر مكعب للفدان

تم إستخدام نوعين من اللقاحات البكتيرية والخاصة بتثبيـت النيتـروجين الجـوى تكافليـا *Rhizobium leguminosarum* bv. *Phaseolus* ولا تكافلي associative N_2-fixersوذلك مع إضافة السماد العضـوى بمعدل ١٠ طن للفدان فى صورة مخاليط بنسب مخلفة من مخلفات المزرعة مع مخلفات مزارع الدواجن وذلك فـى٣٣ معاملة لكل التوافيق المختلفة بين اللقاح البكتيرى والسماد العضوى. أستخدمت تقاوى صنف اكسيرا بمعـدل ٣٥ كجـم للفدان وتم زراعتها فى جور على مسافات ٣٠ سم بين بعضها البعض. أوضحت النتائج المحصل عليها للنباتات عمـر ٥٠ يوم من الزراعة ان استخدام اللقاحات البكتيرية المختلفة فى وجود الجرعة التنشيطية من النيتروجين (٢٠ كجـم ن للفدان) مع السماد العضوى فى النسبة ٣٣,٣% مخلفات المزرعة و ٦٦,٧% مخلفات مزارع الدواجن (OF_3) اعطـت افضل النتائج فى التعقيد والنمو والمحتوى النيتروجينى للنباتات وذلك مقارنة بجميع المعاملات المستخدمة. لـم تسـجل فروق معنوية فى الحصاد الاخضر لنباتات الفاصوليا (٨٠ ، ١٠٠ يوم بعد الزراعة) للمعاملات التى تم استخدام اللقاحات البكتيرية مع وجود المخاليط من السماد العضوى المضاف إليها ٢٠ كجم ن للفدان وذلك مقارنة مع النباتـات المسـمدة بالجرعة الكاملة (٦٠ كجم ن للفدان) والمعاملات الملقحة والمسمدة عضويا فى وجود ٢٠ كجم ن للفدان.

بصفة عامة وجد انه من الافضل استخدام اللقاحات البكتيرية والتسميد العضوى فى وجود الجرعة المرشدة من التسميد النيتروجينى المعدنى للحصول على افضل عقد بكتيرية مكونة ونمو ومحصول لخضر وجاف لنباتات الفاصوليا المنزرعة فى الاراضى الرملية تحت ظروف الإمداد المائى المنخفض فى نظام الرى بالتنقيط.