J. Agric. Sci. Mansoura Univ., 31 (4): 2315 - 2320, 2006

RESPONSE OF PEANUT (*Arachis hypogaea*) TO INDIGENOUS AND INTRODUCED *Bradyrhizobium* SP. STRAINS.

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ABSTRACT.

The response of legumes to inoculation with *Bradyrhizobium* sp. can be affected by many factors. Little work has been undertaken to examine how indigenous populations of rhizobia affect this response. In about 60% of the fields surveyed in the area under investigation in Egyptian new reclaimed soils at Ismaelia, the roots of peanut (*Arachis hypogaea*) plants had no nodules. The aim of this study was determine the effect of inoculation with *Bradyrhizobium sp.* on nodulation and pod yields in peanut. Inoculated plants were compared with the un-inoculated ones receiving nitrogen fertilizer (positive control) and that no fertilized (negative control). In all experiments the nodules dry weight from the inoculated plants was higher than that in the un-inoculated (negative control) or fertilized treatments (positive control). The negative control treatment gave 30% lower yield of peanut than that in inoculated or the N- fertilized treatment, while the latter two treatments gave similar yields. It can be concluded that the use of inoculants have an advantageous and very important to peanut cropping in Egypt .

Keywords: *Arachis hypogaea*, *Bradyrhizobium,* inoculation, nitrogen fixation

INTRODUCTION

Biological nitrogen fixation represents the major source of nitrogen input in agricultural soils including those in new reclaimed regions. The major nitrogen fixing systems are the symbiotic systems, which have a significant role in improving the fertility and productivity of low nitrogen soils. The *Rhizobia* -legume symbioses have received most attention and have been examined extensively. Legume gropes introduced into new area will only form nodules and fix nitrogen if compatible rhizobia are presented in the soil. In recent years peanut (*Arachis hypogaea*) became a major summer crop in some of new reclaimed soils in Egypt. The progressive increase in peanut production may be relevant to improvement high yielding cultivars, through improving nodulation and symbiotic nitrogen fixation using highly efficient *Bradyrhizobium* strains specific to the legume plant (Aliwi, et al, 1989; Abo El-Soud, 1999 and Graham and Vance, 2003). Inoculation with a mixture of specific rhizobia strains in a virgin sandy soil at Ilsalhia, Egypt, produced significant increases in dry matter and nitrogen contents in peanut plants compared to the un-inoculated control (Moawad *et al*, 1988). Similar results were obtained by Nassef, (1989), who found that un-inoculated peanut plants recorded the lowest number, dry weight and nitrogenase activity of nodules as compared with inoculated treatments. Selection of the most effective *Bradyrhizobium* sp. to inoculation for peanut get profitable benefits of nitrogen fixation for both poor sandy soil and standing crop.

MATERIALS AND METHODS

Survey experiment:

A survey covering 30 farmer peanut fields in Ismaelia governorate through the summer growing season of 2004, where the most area of cultivated with peanut in Egypt. Plant samples were taken at the time of pod formation stage. The roots of five representative plants from each field were washed and the nodules presented were detached, counted and weighed after drying for 24 hours at 70°c which given a constant dry weight.

Inoculation experiments:

Three field experiments were conducted in summer growing season of 2004 as follows: the 1st one was conducted in a farmer's field. Plants inoculated with three *Bradyrhizobium* sp. *(Arachis)* strains obtained from Biofertilizer production unit, Soils, Water and Environment Research Institute, ARC. Egypt. (Namely; ARC 601; ARC 6017 and USDA3456), were compared with the positive control which is un-inoculated plants received 90 kg N/fedan (recommended dose) split in three doses, at sowing, beginning of flowering and beginning of pod formation and/or compared with the negative control which do not receive any nitrogen. The five treatments were randomized in five replicates. Each plot consisted of 4 rows, each 6m long, spaced 60 cm apart. Plants were spaced at 10 cm on the row. Just before sowing, the seeds of variety Giza 6 were mixed with three vermiculite based inoculants, at the rate of 300g inoculants /50kg seeds with Arabic gum solution 16% at the rate of 500ml / 50 kg seeds. Irrigation was immediately after sowing. The roots were examined to nodulation at the pod formation stage. At maturity, two middle rows were harvested by hand. Peanut yield, dry matter yield of shoots, 1000 seed weight and shelling percentage (percentage of nut in unshelled peanut) were estimated.

In the other two experiments, three treatments were conducted to be inoculation without N-fertilization, N-fertilization (90 kg N/fedan) and un-inoculated plants without N-fertilization. The three treatments were replicated six times in a randomized complete block design. Inocula in experiment number two was strain *Bradyrhizobium* sp. namely USDA 3456 while *Bradyrhizobium* sp. Strain naming ARC 601 was used in experiment number three.

Phosphorus (15.5% P_2O_5) was incorporated as triple super phosphate into the soil at the rate of 20 kg P_2O_5 /feddan before sowing.

Statistical analysis:

The data were statistically subjected to analysis of variance according to Steel and Torrie (1960).

RESULTS

The obtained results in Table 1. showed that, about 60% of the samples taken from farmer's field had practically no nodules. Total dry weight of nodules per plant was less than 1g, in all cases.

Table 1: Number and dry weight of peanut nodules formed by native *Bradyrhizobium* sp. in Ismaelia farmer fields.

Sample number	Nodules per plant	Dry weight of nodules (g/plant)	Sample number	Nodules per plant	Dry weight of nodules (g/plant)
1	46	0.3	16	54	0.5
2	0	0	17	0	0
3	0	0	18	46	0.6
4	0	0	19	0	0
5	35	0.4	20	0	0
6	48	0.6	21	0	0
7	0	0	22	51	0.7
8	39	0.4	23	0	0
9	0	0	24	43	0.6
10	0	0	25	0	0
11	42	0.5	,25	39	0.5
12	0	0	27	0	0
13	48	0.7	28	37	0.5
14	0	0	29	0	0
15	0	0	30	0	0

In the first experiment, nodules were developed only on the inoculated plants. The Yield of un-inoculated plants was lower than that inoculated with *Bradyrhizobium* sp. Three inoculated treatments were not differed than that fertilized with nitrogen (Table 2).

Table 2: Effect of inoculation with different Bradyrhizobium sp. strains and nitrogen fertilization on the yield of peanut.

Treatment	Pod yield (kg/feddan)	Dry matter of shoots (kg/feddan)	Shelling (%)	Weight of 1000-seed (g)
USDA 3456	1368 a	4028 a	58.1 a	756 a b
ARC 617	1201 a b	4218 a	59.3 a	803 a
ARC 601	1252 a b	3722 a	59.8 a	734 b c
N –fertilizer	1236 a b	5273 a	58.8 a	689 c
Un inoculated	958 b	3714 a	44.7 b	682 c
CV (%)	17.0	29.9	7.0	5.5

Peanut from un-inoculated treatment had lower shelling percentage than those obtained from the other treatments.

In the 2nd and 3rd experiments, pod yield, dry matter yield of shoots and shelling percentage were lower in un-inoculated plants compared with other treatments. There were no significant differences in shelling % and 1000-seed weight, between the conducted treatments (Table 3).

Table 3: Yield of pods and shoots, shelling percentage and 1000-seed weight as affected by *Bradyrhizobium* sp. and nitrogen fertilizer.

Treatment	Pod yield (kg/feddan)	Dry matter of shoots (kg/feddan)	Shelling (%)	Weight of 1000-seed (g)
USDA 3456	2145 a	3480 a	66.8 a	871 a
N-fertilizer	2390 a	3280 a	66.4 a	869 a
Un inoculated	1600 b	2360 a	63.2 b	846 a
CV (%)	22.8	21.4	5.9	5.6

In the 2nd experiment, the number of nodules developed on inoculated plants at flowering and at the stage of pod formation was higher than that developed on un-inoculated and that fertilized with (Table 4). Nitrogen concentration in shoots was higher in inoculated plants (Table 5). In the 3rd experiment, the nitrogen concentration in shoots at harvesting was higher in inoculated plants.

Table 4. Nodulation on the root system of peanut inoculated by specific *Bradyrhizobium* sp.

Treatment	2nd experiment.			3rd experiment		
	Nodule number/pl at flowering	Nodule number/pl at pod formation	Dry Weight (g/pl) of nodule at pod , formation	Nodule number/pl at flowering	Nodule Number/ pl at pod formation	Dry Weight (g/pl) of: nodule at pod formation
Inoculation	56 a	93 a	1.76 a	31 a	68 a	1.16 a
N-fertilizer	4 b	25 b	0.24 b	18 b	57 a	0.36 b
Un inoculated	3 b	12 b	0.13 b	7 b	18 a	0.21 b
CV (%)		12.1	28.2	30.5	57.5	54.4

Table 5. Nitrogen concentration (%) in shoots and nuts of peanut plants.

Treatment	2nd experiment		3rd experiment	
	N%		N%	
	shoots	nuts	shoots	nuts
Inoculation	1.68 a	4.89 a	1.45 a	4.75 a
N-fertilizer	1.45 c	4.43 a	1.31 c	4.58 a
Un inoculated	1.36 b	4.38 a	1.07 b	4.41 a
CV (%)	12.6	7.3	3.5	7.0

DISCUSSION

The survey of peanut cultivation at the area of this study showed that there is a nodulation problem with the peanuts in this area. Even where nodules were developed, they were few and small. This indicated that the

native *Bradyrhizobim* sp. in this soil was lower number, not presented or less effective. Under these conditions, inoculation with efficient specific *Bradyrhizobium* strains should be practiced as well as starter dose of N-fertilization could be recommended. These results are in accordance with Moawad *et al* (1988) and Nassef (1989).

In the inoculation experiments, the un-inoculated unfertilized plants (negative control) in the 2nd and 3rd experiments formed few and small nodules, but no nodules were formed in the 1st one. On the other hand, these treatments produced less parameter yield than the other treatments. The nitrogen came in this treatment either from the soil or fixed from the few nodules developed on the control plants.

The efficiency of *Bradyrhizobium* sp. *(Arachis)* strains was assessed by measuring the productivity of plants and nitrogen yielding, which are the most important components from a farmer's economic point of view. Nitrogen accumulation in plants is recommended as the simplest and most practical method in estimating nitrogen fixation by legumes (LaRue and Patterson, 1981).

In all three experiments it was obvious that inoculation with *Bradyrhizobium* sp. *(Arachis*) can increase pod yield to the same extent as nitrogen fertilization can. Both inoculation and nitrogen fertilization caused, higher yields, in addition to higher shelling percentage.

Inoculation has advantages compared to nitrogen fertilization since the cost of inoculation is far lower than the cost for nitrogen fertilization (Peterson and Russelle,1991). One of the driving forces behind agricultural sustainability is effective management of N in the environment (Graham and Vance, 2002), in addition to these studies, the shoots had higher nitrogen concentration, and higher seed size. It is also known that excess nitrogen fertilization stimulated luxurious vegetative growth which reduces pod yields (Amon,1972 and Graham and Vance,2003).

It can be concluded that inoculation with rhizobia would be expected to cause higher yields in peanut. Moreover, although the different strains of *Bradyrhizobium* sp. used in this study gave consistently higher yields than the un inoculated control, there were differences between the inoculants in nodulation efficiency.

REFERENCES

Abo El-Soud, A. A. (1999).Some aspects of peanut *Bradyrhizobium* symbiosis in some sandy soils. Ph. D., Fac. Of Agric. Cairo Univ.

Aliwi, N., Wynne, J. C., Rawlings, J. 0.; Schneeweis, T. J. and Elkan, G. H. (1989). Symbiotic relationship between Bradyrhizobium strains and peanut. Crop Science, 29, 50-54.

Amon, I., (1972). Crop production in dry regions. Vol.2. Leonard Hi 11, London, 3 55 .

Graham, P. H., Vance, C. P., (2002). Nitrogen fixation in perspective an overview of research and extension needs. Field Crops Res. 65: 93-106.

Graham, P. H. and Vance, C. P., (2003). Legumes: importance and constraints to greater use. Plant Physiology. 2003 Mar., 131 (3): 872-877.

LaRue, T. A. ,Patterson, T. G., (1981). How much nitrogen does legume fix? Advances in Agronomy. 34: 15-38.

Moawad, H.; Badr El-Din, S. M .S.; Kalafalah, M. A.,(1988). Field performance of rhizobial inoculants for some important legumes in Egypt. In: Nitrogen fixation by legume in Mediterranean Agricultural. D. P. Beck and L. A. Matron (eds.), (ICARDA printed in the Netherlands), pp.235-243.

Nassef, M. A. (1989). Interaction between *Bradyrhizobium japonicum* and cowpea rhizobia in relation to nodulation of their hosts. Ph. D., Fac. of Agric. Ain Shams Univ.

Peterson, T. A., Russell, M. P. (1991). Alfaalfa and nitrogen cycle in the corn belt. J. Soil Waiver Conserve. 46: 229-235.

Steel, R . G. and Torrie, H. (1960) Principles and procedures of statistics. Mc Grow – Hill. Inc., Toronto, Canada .

استجابة الفول السودانى لتكوين العقد البكتيرية على الجذور بواسطة التلقيح بسلالات البرادى ريزوبيا المتخصصة أو الريزوبيا المتوطنة بالتربة

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استجابة المحاصيل البقولية لتكوين عقد بكتيرية على جذورها تتأثر بعوامل عديدة، ومن الأهمية دراسة كيفية تأثير الريزوبيا المتوطنة بالتربة والتلقيح بالسلالات المتخصصة على عملية تكوين العقد خاصة بالأراضى حديثة الإستصلاح بمحافظة الإسماعيلية.

تم فى هذه الدراسة عمل حصر للكشف عن تواجد الريزوبيا المتخصصة للفول السودانى المتوطنة فى التربة فى ٣٠ حقل من الحقول المنزرعة بمحافظة الإسماعيلية، كما تم إجراء ثلاثة تجارب حقلية لدراسة تأثير التلقيح بالسلالات المتخصصة على المحصول مقارنة بالنباتات الغير ملقحة أو المسمدة حسب التوصيات السمادية.

وقد أظهرت هذه الدراسة أن حوالى ٦٠ % من الحقول التى فحصت كانت جذور نباتات الفول السودانى المنزرعة بها خالية تماماً من تكوين العقد عليها. كما سجلت النتائج أهمية إجراء عملية التلقيح بواسطة السلالات المتخصصة حيث أدى التلقيح الى تحسين إنتاج المحصول كما ونوعاً وبلغت الزيادة فى المحصول إلى حوالى ٣٠% من وزن البذور مقارنة بالنباتات الغير ملقحة. لذلك فإن هذه الدراسة توصى بضرورة إجراء التلقيح البكتيرى بالريزوبيا المتخصصة لنباتات الفول السودانى خاصة تلك المنزرعة فى الأراضى حديثة الإستصلاح مع إضافة جرعة تنشيطية من السماد النيتروجينى .