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Research Article

PERFORMANCE OF SALT TOLERANT MUTANT RHIZOBIA INOCULATION WITH GRADED LEVELS OF NITROGEN ON THE GROWTH AND YIELD ATTRIBUTES OF GROUNDNUT (*ARACHIS HYPOGAEA L.*)

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ABSTRACT

Groundnut (*Arachis hypogaea L.*) is one of the most important oleaginous plants cultivated in globally and particularly in tropical and subtropical areas (Shiyam, 2010). This crop is commonly cultivated in arid and semi-arid regions of India where it plays an important socioeconomical role. In this field experiment focused, the trails performance of salt tolerant mutant strain *Bradyrhizobium* (GNBJ-9M) at graded levels of nitrogen significantly to improve the growth and yield of groundnut. Among the treatments, T_8-GNBJ-9M+100% N recorded the maximum of plant height, leaf area index, dry matter production, number of nodules plant^{-1}, number of pods plant^{-1}, test weight of 100 seed (g), pod yield ha^{-1}, kernel yield t ha^{-1}, haulm yield t ha^{-1} at harvesting period and also oil content (%), protein content (%) respectively followed by T_7-GNBJ-9M+ 75% N compared to other treatments. The minimum was recorded in the all growth parameters in control treatment of T_1 in groundnut plant.

INTRODUCTION

India is blessed with the agro-ecological condition favourable for growing nine major oil seeds including seven edible oilseeds, namely groundnut, rapeseed-mustard, soybean, sunflower, sesame and niger and two non-edible sources, namely castor and linseed, apart from a wide range of other minor oilseeds and oil-bearing tree species. Among all the oil seed crops, groundnut occupies the first place in India accounting for more than 28% of acreage and 32% of production in the country (Anonymous, 2004). It has been reported that low yield in groundnut is probably due to low nodulation due to competition from strains in the soil which are ineffective with this host. Nodules formed by the native strains may not be able to fix sufficient nitrogen to meet the demand of the plant. But Joshi *et al.* (1989) reported that the *Rhizobium* inoculant has a favorable effect on legumes in groundnut. This inoculant helps to meet the additional nitrogen demand of the plant, by increasing nodulation, enabling realization of the yield potential of the plant.

Groundnut (*Arachis hypogaea L.*) is one of the most important oleaginous plants cultivated in globally and particularly in tropical and subtropical areas (Shiyam, 2010). This crop is commonly cultivated in arid and semi-arid regions of India where it plays an important socioeconomically role (Clavel and Gautreau, 1997).

Indeed, in many developing countries such as India, it is cultivated both for exportation and local consummation. It contains proteins and is one of the major oil yielding crops used in traditional and industrial transformation factories. Although, cultivated areas increased from 2000 to 2012 (from 80.000 to 100.000 ha) but still the yields remain very low (600 to 800 kg ha^{-1}) (MAEP, 2012). There is a continuous degradation in the determining factors of soil fertility with reduction of fallow and fertilizers uses at low level. One of the main constraints for a good productivity of this crop is the nitrogen deficiency in soils (Mohamed and Abdalla, 2013).

To overcome this problem of crop yield reduction, many farmers used chemical fertilizers. Although the chemical fertilizers helped in increasing the yield but, they are commonly associated with soil pollution and their high costs making them unaffordable to smallholder African farmers (Perem, 2011). Apart of the chemical fertilizers, it can be noticed, the uses of bacteria that are able to fixe atmospheric nitrogen in appropriate climatic and pedological conditions (Kishinevsky *et al.*, 1984). Indeed, it has been estimated that

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leguminous plant with symbiotic nitrogen fixing bacteria, are able to fix about 15 to 210 kg ha of nitrogen per season in India (Dakora and Keya, 1997). In many traditional farming systems, crop rotation with groundnut make possible to increase the yield of crop (Nwaga and Ngo Nkot, 1998) because it may highly contribute to increase the soil nitrogen contents (FAO, 1991). The symbiosis of *Rhizobium* and groundnut fixed 70% - 80% nitrogen and fulfill the demand of groundnut nitrogen (Adlan and Mukhtar, 2004). Thus, the inoculation of groundnut with competitive rhizobia revealed to be a beneficial technique (Sharma *et al.*, 2011) because it can considerably improve the growth and productivity and symbiotic parameters of groundnut (Sajid *et al.*, 2011; Mohamed and Abdalla, 2013). Indeed, Sajid *et al.* (2011) was conducted field experiments with soybean and groundnut for selection of suitable *Rhizobium* strains for inoculums production. They obtained good results for various crop parameters such as nodule number, nodule weight and root drymatter etc. during vegetative growth of the crops and increase the yield at maturity. Elsewhere, the response of a promiscuous soybean cultivar to Rhizobial inoculation and phosphorus are study by Muhammad (2010) in the Nigeria and reported that the four Rhizobial inoculants (R25B, IRj 2180A, IRc 461 and IRc 291) were found to increase the parameters as the number of nodules, dry shoot biomass, grain yield, grain N and haulm N content.

Apart of the nitrogen, phosphorus is also an essential nutrient for an efficient growth and yield improvement of the groundnut (Hemalatha *et al.*, 2013). The adoption of sustainable production systems using less or no chemical inputs and the valorization of nitrogen fixing bacteria in association with phosphorus supply may be an appropriate way for improving groundnut productivity in India. Unfortunately, there is a lake of information related to rhizobial inoculation responses of groundnuts in Benin. Thus, the aim of the present study was to assess the performance of introduced mutant strain of *Bradyrhizobium* in association with nitrogen application on the productivity of groundnut in Tsunami affected coastal area of Cuddalore district of Tamilnadu.

MATERIALS AND METHODS

Plant material

The groundnut variety VRI-2 was collected from Agricultural farm, Annamalai University and used for the present trials.

Bradyrhizobium inoculum

Three *Bradyrhizobium* strain GNBJ-9M was obtained from the groundnut plant used for experimentations. The lignite was used as carrier for the inoculum preparation it is neutralized by 0.30% of $CaCO_3$.The mixture was sterilized at 121°C for 1hrs (Menaka and Alagawadi, 2007). Twenty (20) ml of bacterial strain suspension were used to inoculate in 75g of peats packaged in thermoresistant polypropylene bags in aim to obtain 2.8 x 10^8 CFU/g. The groundnut seeds (15 kg).

Experimental design

The field experiment was conducted in Samiyarpettai village of Cuddalore district in the year of 2008. The experiments were led out in a randomized block design on two factors with three replicates per communes.

Treatment details

T_1	-	Control (N)
T_2	-	50% N
T_3	-	75% N
T_4	-	100% N
T_5	-	GNBJ-9M
T_6	-	GNBJ-9M +50% N
T_7	-	GNBJ-9M +75% N
T_8	-	GNBJ-9M +100% N

Eight treatment plots were prepared and irrigated immediately for a better accommodation. Three replications were maintained for each treatment subsequent irrigation was done two times in a week to keep the optimum moisture level of the soil.

Growth promoting effects of bacterial treatments were evaluated by determining the plant height, leaf area index, dry matter production on 30 DAS, 60 DAS and at harvest period and the number of nodules, number of pods plant^{-1}, test weight (g), pod yield ha^{-1}, kernel yield t ha^{-1}, haulm yield t ha^{-1} at harvesting period and also oil content, protein content were analysed.

Statistical analysis

Data was subjected to one-way analysis of variance (ANOVA) followed by Duncan's multiple range test (DMRT) as per procedures described by Gomez and Gomez (1984). Values represent mean±SD for three samples in each group. P values are <0.05 were considered as significant.

RESULTS AND DISCUSSION

Plant height of groundnut

The effect of treatments on the height of groundnut plants has revealed that the highly significant in the all the treatments while it is significant ($p<0.05$). Among the eight treatments, the treatment T_8- GNBJ-9M + 100% N recorded the maximum plant height at harvest of 50.60 cm followed by T_7-GNBJ-9M+75% N and other treatments respectively. The minimum plant height was recorded in control treatment of T_1 in groundnut. The results are presented in Table-1.

Table 1 Effect of salt tolerant mutant GNBJ-9M inoculation at graded levels of nitrogen on the plant height of groundnut var. VRI-2 under field condition

S. No	Treatments	Plant height (cm)			
		30 DAS	60 DAS	At harvest	% increase over control at harvest
1.	T_1- Control (N)	20.15	31.45	38.50	-
2.	T_2- 50% N	23.75	35.20	40.35	25.30
3.	T_3- 75% N	25.20	37.80	43.44	32.30
4.	T_4- 100% N	29.45	40.25	49.33	43.45
5.	T_5- GNBJ-9M	22.18	34.00	39.75	43.60
6.	T_6- GNBJ-9M +50% N	29.00	41.50	49.00	38.63
7.	T_7- GNBJ-9M +75% N	29.45	41.00	48.75	43.18
8.	T_8- GNBJ-9M +100% N	30.80	42.20	50.60	44.20
	SED	0.74	0.83	1.10	-
	CD (P=0.05)	1.28	1.36	2.15	-

The similar result was also confirmed with the result of Basu *et al.* (2006).

Leaf area index of groundnut

In general all the treatments were significantly increased in leaf area index ($p<0.05$) in groundnut plant. The eight treatments, T_8- GNBJ-9M + 100% N recorded the maximum leaf area index of 3.52 at harvest level followed by T_7- GNBJ-9M + 75% N and the other treatments respectively. The minimum leaf area index was recorded in the treatment of T_1 (Fig-1). The similar result was also confirmed with the result of Basu and Bhadoria (2008); Mohamed and Abdalla (2013).

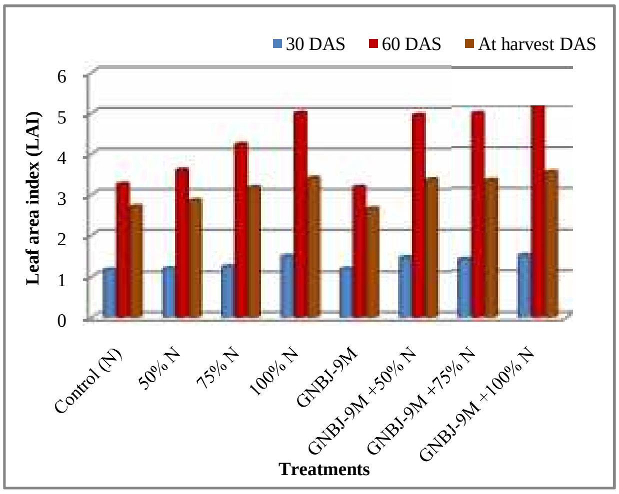

Figure 1 Effect of salt tolerant mutant GNBJ-9M inoculation at graded levels of nitrogen on the leaf area index of groundnut var. VRI-2

Dry matter production of groundnut

In general the salt tolerant mutant rhizobial inoculation at graded levels of nitrogen in groundnut had recorded the significantly increased in all sampling periods. Among the eight treatments, T_8- GNBJ-9M + 100% N recorded the maximum of dry matter production (7.15 t ha^{-1}) followed by T_7- GNBJ-9M + 75% N of 6.88 t ha^{-1} when compared to other treatments. The minimum was recorded in control treatment (T_1). The results are presented in Fig-2. In the results was worked out by the researchers (Kishinevsky *et al.*, 1984; Gueye, 1986; Hussain *et al.*, 2010).

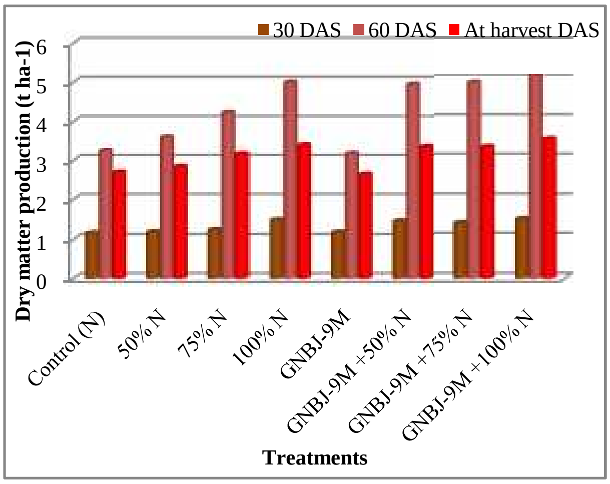

Figure 2 Effect of salt tolerant mutant GNBJ-9M inoculation at graded levels of nitrogen on the dry matter production of groundnut var. VRI-2

Number of nodules per plant in groundnut

In comparison to the control, all the treatment displays significant increases in the average number of nodules per plant ($p< 0.05$). Among the treatments, T_8- GNBJ-9M + 100% N recorded the maximum number of nodules of 40.15 nodules per plant at harvest period followed by T_7- GNBJ-9M + 75% N of 38.45 respectively when compared to other treatments in groundnut. The results are presented in Table-2. This results also supported in groundnut plant of Shaheen and Rahmatullah (1994); Sharma *et al.* (2011).

Table 2 Effect of salt tolerant mutant GNBJ-9M inoculation at graded levels of nitrogen on the number of nodules $plant^{-1}$ of groundnut var. VRI-2

S. No	Treatments	Number of nodules $plant^{-1}$
1.	T_1- Control (N)	28.56
2.	T_2- 50% N	33.45
3.	T_3- 75% N	36.00
4.	T_4- 100% N	38.10
5.	T_5- GNBJ-9M	32.15
6.	T_6- GNBJ-9M +50% N	39.00
7.	T_7- GNBJ-9M +75% N	38.45
8.	T_8- GNBJ-9M +100% N	40.15
	SED	0.72
	CD (P=0.05)	1.24

Number of pods plant^{-1} and test weight (g) in groundnut

All the treatments were significantly increased at harvesting period ($p<0.05$). The maximum number of pods (39.28) and test weight (48.26 g) received the treatment T_8- GNBJ-9M + 100% N followed by T_7- GNBJ-9M + 75% N when compared to other treatments respectively in groundnut (Fig-3). The present findings are accordance with the results of Hussain *et al.* (2010); Shiyam (2010).

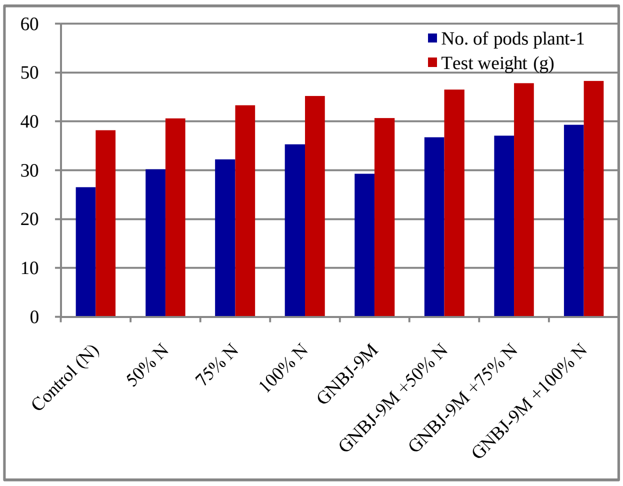

Figure 3 Effect of salt tolerant mutant GNBJ-9M inoculation at graded levels of nitrogen on the number of pods $plant^{-1}$ and test weight of groundnut var. VRI-2

Pod yield, kernel yield and haulm yield of groundnut

In general the rhizobial inoculation had significantly increased the growth parameters at harvesting period. Among the treatments, the treatment T_8- GNBJ-9M + 100% N recorded the pod yield of 2.42 t ha^{-1}, kernel yield of 1.67 t ha^{-1} and haulm yield of 6.25 t ha^{-1} followed by T_7- GNBJ-9M + 75% N of 2.30 t ha^{-1}, 1.58 t ha^{-1} and 6.25 t ha^{-1} respectively when compared to other treatments. The minimum was recorded in treatment (T_1). The results are presented in Fig-4. Several workers also reported in groundnut yield (Son *et al.*, 2007; Yakubu *et al.*, 2010; Sharma *et al.*, 2011).

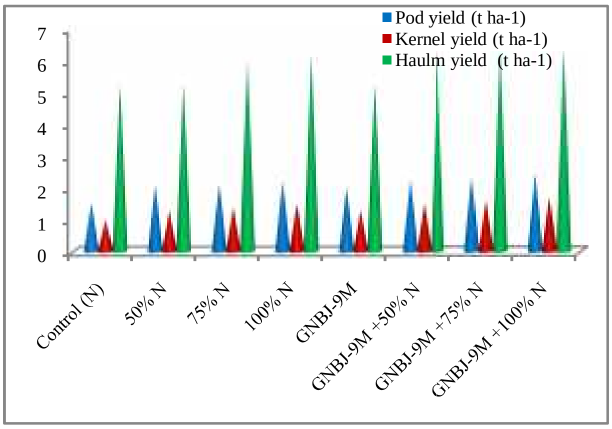

Figure 4 Effect of salt tolerant mutant GNBJ-9M inoculation at graded levels of nitrogen on the number of pod yield, kernel yield and haulm yield of groundnut var. VRI-2

Oil content and protein content of groundnut

The oil content and protein content were significantly increased in all the treatments and the results are presented in Fig-5. Among the treatments, T_8- GNBJ-9M + 100% N received the maximum oil content and protein content of 4.75% and 27.75% followed by T_7- GNBJ-9M + 75% N respectively. The minimum was recorded in the treatment of T_1 in groundnut. The present results of oil content and protein content were significantly increased due to inoculation of salt tolerant mutant strain at graded levels of nitrogen application. This study also reported by several researchers (Hussain *et al.*, 2010; Sajid *et al.*, 2011; Sharma *et al.*, 2011; Mohamed and Abdalla, 2013).

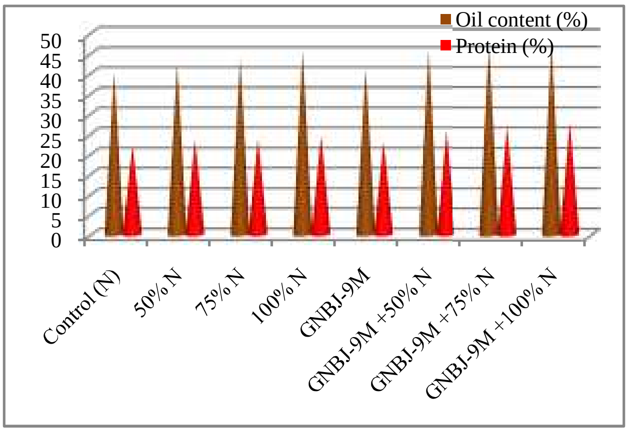

Figure 5 Effect of salt tolerant mutant GNBJ-9M inoculation at graded levels of nitrogen on the oil content and protein content of groundnut var. VRI-2

CONCLUSION

The present study clearly indicated that the inoculation of *Bradyrhizobium* GNBJ-9M at graded levels of nitrogen had significantly improved the growth and yield parameters of groundnut in Tsunami affected coastal regions of Cuddalore district of Tamilnadu. Hence, the same strain can recommended for a commercial biofertilizer whereas grown in groundnut and other oil seed crops.

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