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Effect of *Rhizobium* inoculation with different sowing dates and levels of nitrogen on growth and yield of groundnut (*Arachis hypogaea* L.)

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In field trial at Teaching Farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal in the pre *kharif* (summer)season of 2001groundnut cv. JL 24 was sown on 17 Jan, 1 Feb, 15 Feb and 2 March with varying levels of nitrogenous fertilizer (0 and 20 kg N/ha in the form of urea) and *Rhizobium* inoculation (strain GN 2/ 90). Significant difference among the dates of sowing in the production of dry weight of shoot, nodulation per plant and finally pod yield of groundnut was observed. Among the four dates of sowing, 1 Feb. sowing was found to record the best results regarding shoot dry weight, nodule number and dry weight of nodule per plant and finally pod yield of groundnut and these results were significantly superior to all other dates of sowing. Nitrogen application improved the dry weight of the shoot consequently the pod yield of groundnut over control. Plant growth, nodulation, nodular weight, leghaemoglonin content were significantly increased due to inoculation with *Rhizobium* which led to improve the yield attributes and finally yield of groundnut.

Key words : *Rhizobium,* inoculation, nodulation, leghaemoglobin, nodule, strain

INTRODUCTION

The cultivated groundnut (*Arachis hypogaea* L.) a leguminous crop is generally grown as a *kharif* (rainy season) crop in our country. Response of groundnut to different dates of sowing was observed by Patel and Podder (1985) and More and Khadke (1987). Like other legumes plants groundnut is also capable of fixing atmospheric nitrogen by root nodules bacteria. Groundnut is predominantly nodulated by *Rhizobium* of the cowpea misclleny (Freed *et al.*, 1932). When nodulated with effective (nitrogen fixing) bacteria groundnut nodule fix most of the nitrogen requirements of the crop. Bell (1986) conducted field trails in 1982-83 wet season. In this experiment groundnut were sown with 5 dates from 7th December to 1st March and observed that proportion of vegetative dry matter was affected by sowing date so that leaf stem ratio increased about 75 days after sowings. Mali *et al.* (1988) also observed the some results. Poi and Kabi (1983) reported that in groundnut cultivar TMV-1 rhizobium inoculation significantly increased fresh weight and nitrogen content of pot sown plants. seed inoculation with *Rhizobium* strain increased nodulation and pod yield of field grown groundnut (Pal, 1986; Raverkar and Konde, 1988; Sridhar *et al.*, 1989 and Alagawadi *et al.*, 1983). Higher yield is obtained when the crop is grown during pre-*kharif* (summer) season (Joshi and Kulkarni, 1984). Although, it is known that cultivation of groundnut in pre-*kharif* season with irrigation facilities gives highest yield in our condition, information regarding the optimum date of sowing is not adequate. Further, very little studies have been made regarding N-fertilization and *Rhizobium* inoculation on this crop.

MATERIALS AND METHODS

The experiment was conducted at Teaching Farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal during pre-*kharif* season in the year

2001 to study the nodulation, growth and yield of groundnut (*Arachis hypogaea* L.) cultivar JL 24 (Phule Pragati) sown at different dates 17 January (S_1), 1 February (S_2), 15 February (S_3) and 2 March (S_4) with varying levels of nitrogenous fertilizer @ 0 kg/ha (N_0) and 20 kg/ha (N_1) and 2 levels of *Rhizobium* inoculation i.e. uninoculated (R_0) and inoculated (R_1). *Rhizobium* inoculation was done by seed baclerigation method. A basal dose of 60 kg P_2O_5 and 40 kg K_20 per hactare through single super phosphate and muriate of potash respectively was given to all the experimental plots. The experimental field was situated on high land with assured irrigation. The soil of the field was and had silty loam and had good drainage condition and irrigation facilities. The experiment was laid out in split plot design with three replications. The each plot size was 3m x 2m. To determine the nitrogen content in plant, samples were taken at the harvesting time Modified Micro- kjeldahl Method (Jackson, 1967) of analysis was used for nitrogen determination.

RESULTS AND DISCUSSION

Effect of date of sowing, application of nitrogen and Rhizobium inoculation on dry weight of shoot per plant of groundnut

The effect of date of sowing on the dry weight of shoots per plant or groundnut was found to be significant (Table 1). The highest dry weights 1.80g, 8.62g and 18.52g were obtained at 40,60 and 80 days after sowing (DAS) when the nuts were sown on 1 February and these dry weights were significantly superior to those recorded from all other sowings. Among the rest of the sowing dates 17 January sowing produced the lowest dry weights at 60 and 80 DAS but these were at par with the dry weights recorded from 15 February and 2 March sowings. Bell (1986) also observed difference in dry matter production of groundnut when sowing dates were different.

Increase in dry weight of shoots per plant of groundnut from 1.36 g, 6.67 g and 16.27 g at control to 1.72 g, 7.49 g and 17.25 g, with application of nitrogen at 40, 60 and 80 DAS was observed (Table 1). This increment was significant.

Inoculation with *Rhizobium* significantly increased the dry weight of shoots per plant of groundnut than uninoculated control at 80 DAS. No significant effect of inoculation was observed at 40 and 60 DAS on the dry weight of shoots per plant (Table 1). Similar results has been reported by Poi and Kabi (1983).

Table 1 : Effect of date of sowing, nitrogen level and *Rhozobium* inoculation on dry weight of shoot per plant of groundnut.

Treatments	40 DAS	60 DAS	80DAS
Date of sowing			
S_1 (17 January)	1.47	6.48	16.08
S_2 (1 February)	1.80	8.62	18.52
S_3 (15 February)	1.47	6.51	16.32
S_4 (2 March)	1.41	6.71	16.14
CD at 5%	0.13	0.38	0.54
Levels of nitrogen			
N_0 (O kg/ha)	1.36	6.67	16.27
N_1 (20 kg/ha)	1.72	7.49	17.25
CD at 5%	0.09	0.17	0.23
Levels of *Rhizobium* inoculation			
R_0 (Uninoculated)	1.52	6.74	16.19
R_1 (Inoculated)	1.53	7.38	17.32
CD at 5%	NS	0.20	0.15

DAS = Days after sowing

Effect of date of sowing, application of nitrogen and Rhizobium inoculation on nodule number per plant of groundnut

Nodule number was significantly influenced by different dates of sowing (Table 2). 1 February showed the maximum number of nodules at three dates of observations, which were significantly higher than the nodules produced from the rest dates of sowing. 17 January sowing produced nodules significantly more than those produced by 15 February and 2 March sowing. 2 March sowing showed the lowest number and was significantly lower than that obtained from 15 February sowing at 40 and 60 DAS. However, at 80 DAS significantly lowest nodules number was observed at 15 February sowing.

Application of nitrogen was found to improve nodulation of groundnut than control (Table 2). At 40 DAS, there was a significant reduction in number of nodules due to nitrogen application. At later stage of plant growth i.e. at 60 and 80 DAS the

significant beneficial effect of applied nitrogen might have been responsible for low nodulation at earlier part of growth. In the latter part higher crop growth due to N-application might have been conducive to better nodulation.

Table 2 : Effect of date of sowing, nitrogen level and *Rhozobium* inoculation on number of nodules per plant of groundnut.

Treatments	40 DAS	60 DAS	80DAS
Date of sowing			
S_1 (17 January)	30.75	48.39	116.69
S_2 (1 February)	33.75	53.83	119.77
S_3 (15 February)	28.49	46.67	112.89
S_4 (2 March)	27.58	43.24	114.51
CD at 5%	1.40	1.35	1.76
Levels of nitrogen			
N_0 (O kg/ha)	30.98	45.55	111.34
N_1 (20 kg/ha)	29.31	50.52	120.59
CD at 5%	0.35	0.50	1.42
Levels of *Rhizobium* inoculation			
R_0 (Uninoculated)	26.64	40.75	103.32
R_1 (Inoculated)	33,64	55.32	128.61
CD at 5%	0.54	5.02	1.85

DAS = Days after sowing

Significant effect of *Rhizobium* inoculation on the number of nodules per plant of groundnut was found (Table 2). At 40, 60 and 80 DAS inoculation was found to improve nodulation of groundnut over control. More nodulation by addition of *Rhizobium* is self explanatory. Similar results have been reported by Alagawadi and Siddaramegowda (1983); Pal (1986) and Raverkar and Konde (1988). Effect of date of sowing, application of nitrogen and *Rhizobium* inoculation on dry weight of nodules per plant of groundnut

Dry weight of nodules was significantly influenced by different dates of sowing (Table 3). The nodular dry weights at 40, 60 and 80 DAS were the maximum when groundnut was sown on1 February and these weights were significantly higher than those obtained from the rest of sowings at 40 and 60 DAS. At 80 DAS the nodular dry weight obtained from this sowing was superior to others but at par with 17 January sowing. The maximum weights were obtained from 2 March sowing which were significantly lower those obtained from all other sowings at 40 and 80 DAS. At 60 DAS, the nodular dry weight at par with each other.

Notrogen application increased nodular dry weight over control significantly at 40, 60 and 80 DAS (Table 3).

Table 3 : Effect of date of sowing, nitrogen level and *Rhozobium* inoculation on dry weight (mg) of nodules per plant.

Treatments	40 DAS	60 DAS	80DAS
Date of sowing			
S_1 (17 January)	24.06	41.57	100.50
S_2 (1 February)	26.72	42.80	100.79
S_3 (15 February)	23.29	39.54	97.70
S_4 (2 March)	19.33	39.36	95.70
CD at 5%	0.75	0.70	0.70
Levels of nitrogen			
N_0 (O kg/ha)	22.00	39.84	98.33
N_1 (20 kg/ha)	24.69	41.80	98.98
CD at 5%	0.25	0.41	0.46
Levels of *Rhizobium* inoculation			
R_0 (Uninoculated)	20.66	38.81	93.99
R_1 (Inoculated)	26.04	42.82	103.31
CD at 5%	0.42	0.26	0.57

DAS = Days after sowing

Favourable influence of *Rhizobium* inoculation on nodular dry weight was observed. In all observations, inoculation significantly increased the nodular dry weights of groundnut over uninoculated control. Alagawadi *et al.*, (1983) reported similar results.

Inoculation with *Rhizobium* produced significant increase over uninoculated control in the nodular dry weight in all the dates of sowing (Table 3).

At uninoculated level, highest dry weight of nodules was obtained at 80 DAS from 1 February sowing which was at per with 17 January but these were significantly greater than those obtained from 15 February and 2 March. However, 17 Januai y, 1 February and 15 February sowings were at par.

Inoculation resulted in the significant increase in the nodular dry weight than control in all the dates of sowing (Table 3).

Effect of date of sowing, application of nitrogen and Rhizobium inoculation on leghaemoglobin content (mg/g) of nodules

Date of sowing could not significantly influence the

leghaemglobin content of nodules of groundnut (Table 4).

Table 4 : Effect of date of sowing, nitrogen level and *Rhozobium* leghaemoglobin content (mg/g) of nodules.

Treatments	Date on 70 days after sowing
Date of sowing	
S_1 (17 January)	1.65
S_2 (1 February)	1.65
S_3 (15 February)	1.66
S_4 (2 March)	1.66
CD at 5%	NS
Levels of nitrogen	
N_0 (O kg/ha)	1.57
N_1 (20 kg/ha)	1.73
CD at 5%	0.02
Levels of *Rhizobium* inoculation	
R_0 (Uninoculated)	1.47
R_1 (Inoculated)	1.57
CD at 5%	0.024

Application of nitrogen favourably influenced the leghaemoglobin content of nodules of groundnut.

The leghaemoglobin content of groundnut nodules was significantly influenced by *Rhizobium* inoculation. The leghaemoglobin content increased when the seeds were inoculated with *Rhizobium* over uninoculated seeds.

Effect of date of sowing, application of nitrogen and Rhizobium inoculation on uptake of nitrogen the shoots and leaves of groundnut

Nitrogen uptake by groundnut plants was found to be significantly influenced by date or sowing (Table 5). The uptake was highest when date of sowing was 1 February and this uptake was on at par with that observed from 17 January sowing. The uptake obtained at these two sowing dates were significantly more than those produced at rest of the sowings. 2 March sowing recorded the minimum uptake which was significantly lower than those observed at other sowing dates.

Nitrogen application favourably influenced the uptake of nitrogen by groundnut plants over control (Table 5). The uptake increased from 94.56 kg/ha at control to 99.45 kg/ha at 20 kg N/ha application. This has the conformity with the results obtained by Mali *et al.* (1988).

Table 5 : Effect of date of sowing, nitrogen level and *Rhozobium* level on uptake of nitrogen (kg/ha) of shoots and leaves of groundnut.

Treatments	Uptake of nitrogen (kg / ha)
Date of sowing	
S_1 (17 January)	9.29
S_2 (1 February)	99.76
S_3 (15 February)	95.81
S_4 (2 March)	93.16
CD at 5%	1.00
Levels of nitrogen	
N_0 (O kg/ha)	94.56
N_1 (20 kg/ha)	99.45
CD at 5%	0.15
Levels of *Rhizobium inoculation*	
R_0 (Uninoculated)	94.14
R_1 (Inoculated)	99.87
CD at 5%	0.85

Significant effect of *Rhizobium* application on the uptake of nitrogen by groundnut plants was observed. Inoculation with *Rhizobium* increased the uptake of N over uninoculation from 94.14 kg/ha to 99.87 kg/ha (Table 5).

Effect of date of sowing, application of nitrogen and Rhizobium inoculation on yield of groundnut

The effect of date of sowing on the yield of groundnut was found to be significant (Table 6). The highest yield was obtained when the nuts were sown on 1 February and the yield obtained at this date of sowing was significantly higher than those obtained from all other dates of sowing. Earlier and later sowing dates decreased pod yield significantly and the pod yield was the lowest when groundnut was sown on 2 March. The decreased in pod yield over 1 February sowing was due to an increase in yield attributing characters. This is in conformity with the studies of Patel and Poddar (1985), More and Khadke (1987).

Nitrogen increased pod yield significantly than control 20 kg N/ha gave an additional yield of 1.8 g/ha over control. Mali *et al.*, (1988) reported of such beneficial effects of N application.

Inoculation with *Rhizobium* significantly increased

the yield of groundnut over uninoculated control (Table 6). Yield of groundnut increased from 2.03 t/ha in uninoculated control to 2.57 t/ha when *Rhizobium* was inoculated. This was due to an increase in the number of pods per plant and test weight of groundnut. Similar results have been reported by Alagawadi *et al.*,(1983). Joshi and Kulkarni (1984), Raverkar and Konde (1988) and Sridhar *et al.*, (1989).

Table 6 : Effect of date of sowing, nitrogen level and *Rhozobium* inoculation on yield (t/ha) of groundunt.

Treatments	Yield t / ha
Date of sowing	
S_1 (17 January)	2.35
S_2 (1 February)	2.58
S_3 (15 February)	2.22
S_4 (2 March)	2.06
CD at 5%	1.27
Levels of nitrogen	
N_0 (O kg/ha)	2.21
N_1 (20 kg/ha)	2.39
CD at 5%	0.17
Levels of *Rhizobium inoculation*	
R_0 (Uninoculated)	2.03
R_1 (Inoculated)	2.57
CD at 5%	0.19

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