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Effect of different levels of nitrogen and sulphur with or without biofertilizer on nodulation and plant growth of mungbean

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Abstract: A field experiment was conducted at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during the period from February/2008 to April/2009 to evaluate the effect of N and S fertilizers with or without bio-fertilizer (*Bradyrhizobium*) on nodulation and plant growth of Binamoog-6. The experiment was laid out in Randomized Complete Block Design (RCBD) with nine treatments and three replications. The treatments were T_1-N_0S_0, T_2-N_0S_5 T_3-$N_0S_{10,}$ T_4-$N_{15}S_0$, T_5-$N_{15}S_5$, T_6-$N_{15}S_{10}$, T_7-$N_{30}S_0$, T_8-$N_{30}S_5$ and T_9-$N_{30}S_{10}$ with or without bio-fertilizer (*Bradyrhizobium*). Data were recorded at 35 days after sowing (DAS), 49DAS and at harvest. There were significant variations among the different treatments combination in terms of nodulation and plant growth. Result showed that *Bradyrhizobium* inoculation significantly increased the number of nodules plant^{-1}, nodule dry weight plant^{-1} and plant dry weight. The highest nodule number plant^{-1} (62.13 at 49 DAS), nodule dry weight plant^{-1} (115.40mg at 49 DAS) and plant dry weight (15.08gm at harvest) were recorded in $I_1N_0S_{10}$ treatment. The result revealed that the inoculation of bio-fertilizer (*Bradyrhizobium*) significantly increased the plant growth and nodulation of Binamoog-6.
Key words: Biofertilizer, nodulation, plant growth

Introduction

Pulses occupy a unique position in agriculture due to its high protein in seed and capacity of fixing atmospheric nitrogen. Legumes have been building and conserving soil fertility since the beginning of Agriculture. Mungbean [*Vigna radiata* (L.) Wilczek] is one of the most important pulse crops of Bangladesh. It originated in south Asia (India, Burma, Thailand etc) but now it is widely grown in India, Pakistan, Bangladesh, Burma, Thailand, Philippines, China and Indonesia. It is also grown in parts of east and central Africa, the west-Indies, USA and Australia (Gowda and Kaul, 1982). Summer mungbean can tolerate a high temperature not exceeding 40°C and grows well in the temperature range of 30-35°C. In our country, mungbean gives the highest yield under summer planting (Satter and Ahmed, 1995). The possibilities of growing mungbean in summer are being experimented and some successes have already been made in Bangladesh. One of the biggest advantages of summer pulses is their suitability for early Kharif, particularly in the areas where low yielding Aus is produced. Experiments conducted at BARI indicate that summer pulses like mungbean are more economical than low yielding Aus rice. In a developing country like Bangladesh, pulse can improve the overall nutritional value of cereal based diet. Unfortunately, there is an acute shortage of grain legumes production in the country. Mugbean has especial importance in intensive crop production system of the country for its short growing period (Ahmed *et al*., 1978). As a legume mungbean is capable of utilizing atmospheric nitrogen through symbiotic association with *Bradyrhizobium* sp. From the point of nutritional value, mungbean is perhaps the best of all other pulses (Khan *et al.*, 1982). In mungbean seed, there are 51% carbohydrate, 26% protein, 3% minerals and 3% vitamins (Kaul, 1982). In Bangladesh inoculation with *Bradyrhizobium* increased 57% effective nodule, 77% dry matter production, 64% grain yield and 40% hay yield over uninoculated control in mungbean cultivation (Chanda *et al*.,1991). The major objectives of this study was to evaluate the effect of *Bradyrhizobium* inoculation with nitrogenous and sulphur fertilizers on the nodulation and plant growth of summer mungbean.

Materials and Methods

The experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) Farm, Mymensingh during the period from February to April 2008-2009. The experimental area was characterized by high temperature and heavy rainfall during the *kharif* season (March-September) and low rainfall and moderately low temperature during *rabi* season (October-February) to evaluate the effect of N and S fertilizers with or without bio-fertilizer (*Bradyrhizobium*) on nodulation and plant growth of summer mungbean (*Vigna radiata* L.) cv. Binamoog-6. The experiment was laid out in Randomized Complete Block Design (RCBD) with nine treatments and three replications. The treatments were T_1-N_0S_0, T_2-$N_0S_{5,}$ T_3-$N_0S_{10,}$ T_4-$N_{15}S_0$, T_5-$N_{15}S_5$, T_6-$N_{15}S_{10}$, T_7-$N_{30}S_0$, T_8-$N_{30}S_5$ and T_9-$N_{30}S_{10}$ kg ha^{-1} with or without bio-fertilizer (*Bradyrhizobium*) having a size of each plot was 3 x 2m^2 with a distance between two adjacent blocks were 0.5m and between plots 0.40m ails were prepared. The initial soil sample was analyzed for texture, P^H, organic carbon, total nitrogen, available phosphorous by using the appropriate methodology. A basal dose of K fertilizer at the rate of 35 kg K ha^{-1} as muriate of potash (MoP), phosphorus fertilizer at the rate of 20 kg P ha^{-1} as triple super phosphate (TSP), sulphur fertilizer as gypsum and nitrogen fertilizer as half urea was applied at final land preparation. The rest of half urea was applied 25 days after sowing (DAS). The fertilizers were then mixed well with the soil by spading and individual unit plots were leveled. The *Bradyrhizobial* inoculants BINA T301 and BINA 301were prepared in Soil Microbiology and Bio-fertilizer Laboratory, BINA, Mymensingh. Viability count of *rhizobia* in the yeast extract mannitol broth media was made on the day before use the plate count method (Vincent, 1974). Before inoculant mixed with seeds and made black with each seed, molasses was added and mixed thoroughly with seed so that all the seed coats became sticky. Seeds were sown into the furrow maintaining a line to line distance of 40 cm and the furrows were covered by soils soon after seeding. Two wedding and thinning were done at 8-10cm and 22-25cm of plant height maintaining a plant to plant distance was 8

cm. Control of insect and pathogen and drainage of rain water was done as and when necessary. Data were recorded at 35 days after sowing (DAS), 49 DAS and at harvest. From each plot, 5 randomly selected plants were carefully uprooted with the help of a nirani so that no nodule was left in the soil. The nodules from main and branch root of each plant were collected and counted after carefully washed in water. Finally plant and nodule fresh weight and dry weight were recorded. All pods of mungbean was not matured at a time so, the crop was harvested in two times. The pod and straw from every plot was harvested separately. From each plot 5 randomly selected plants were collected at harvesting period and then plants of 2.5 sq. m. were harvested and tied with rope separately. Data on number of pods and grains plant^{-1}, 1000-grain weight were recorded from 10 plants. After 4 days sun drying processed grain and straw were again dried in the sun for 3 days. Grain and straw yields were recorded plot wise and converted in to kg ha^{-1}. The analysis of variance for various characters of mungbean and nutrient content was done following the F-statistics. The mean comparison of the treatments was made by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Nodule number plant^{-1}: Nodule number plant^{-1} of Binamoog-6 was influenced significantly due to rhizobial inoculcation at 35 days after sowing (DAS), 49 DAS and harvest stage (Table 1). There were significant variations between uninoculated and inoculated in the formation of total nodules. Inoculated plants Binamoog-6 showed significant higher number of nodules compared to that of uninoculated plants. The highest number of nodules (43.77) was found in I_I (Inoculated) treatment at 49 DAS and the lowest number (10.98) was found in I_0 (Uninoculated) plants at harvest stage. The different levels of fertilizers and bio-fertilizer showed significant variation in the formation of nodules and the application of *Bradyrhizobium* significantly increased the formation of nodules. The nodule numbers decreased progressively with higher doses of nitrogen. The highest number of nodules (50.65) was found in N_0S_{10} treatment at 49 DAS and the lowest number (7.80) was found in $N_{30}S_0$ treatment at harvest stage (Table 1).

Nodule dry weight: The nodule dry weight of Binamoog-6 recorded at 35 DAS, 49 DAS and harvest stage was significantly affected by rhizobial inoculation (Table1). Inoculated Binamoog-6 showed significant higher nodule dry weight compared to that of uninoculated plants. The highest nodule dry weight (81.48 mg) was found in I_I (Inoculated) treatment at the 49 DAS and the lowest nodule dry weight (23.20 mg) was found in I_0 (Uninoculated) condition at harvest stage. The different levels of fertilizers and bio-fertilizer showed significant variation in nodule dry weight and the application of *Bradyrhizobium* significantly increased the nodule dry weight. The highest nodule dry weight (97.30) mg was found in N_0S_{10} treatment at 49 DAS and the lowest (16.05) mg was found in $N_{30}S_0$ treatment at harvest stage (Table1).

Table 1. Effect of different levels of N and S fertilizers with or without bio-fertilizer on nodulation and plant dry weight of Binamoog-6

Treatments	No. of nodules plant^{-1}			Nodule dry weight (mg)			Plant dry weight (gm)		
	35 DAS	49 DAS	Harv. stage	35 DAS	49 DAS	Harv. stage	35 DAS	49 DAS	Harv. stage
With or without bio-fertilizers									
I_0	17.26	28.34	10.98	33.68	54.51	23.20	1.27	2.11	11.11
I_I	27.77	43.77	17.48	60.25	81.48	35.82	1.56	2.65	12.51
LSD $_{0.05}$	0.86	0.78	0.86	2.042	1.18	1.07	0.059	0.23	0.24
Different levels of N and S fertilizers with or without bio-fertilizer									
N_0S_0	23.74	40.22	14.84	48.80	68.69	29.50	1.41	2.52	12.86
N_0S_5	26.39	44.32	16.85	53.76	78.20	34.35	1.70	2.76	13.06
N_0S_{10}	33.44	50.65	18.85	66.95	97.30	42.55	2.01	3.10	13.59
$N_{15}S_0$	22.81	35.24	15.03	51.70	69.70	30.83	1.32	2.39	11.55
$N_{15}S_5$	23.65	35.91	15.20	49.05	70.30	29.36	1.42	2.38	11.54
$N_{15}S_{10}$	27.35	47.28	16.78	58.50	81.92	35.50	1.66	2.69	13.26
$N_{30}S_0$	10.97	15.84	7.80	21.00	30.80	16.05	0.90	1.62	8.67
$N_{30}S_5$	15.66	25.48	10.57	33.70	54.50	22.31	1.13	2.03	10.81
$N_{30}S_{10}$	18.68	29.56	12.13	39.26	60.55	25.15	1.20	1.92	10.94
LSD $_{0.05}$	1.82	1.64	1.81	4.30	2.48	2.26	0.123	0.48	1.47

I_0 = Uninoculated, I_I = Inoculated, Harv. Stage = Harvest stage, N_0, N_1, N_2= 0, 15, 30kg ha^{-1} nitrogen and S_0, S_1, S_2 = 0, 5, 10kg ha^{-1} sulfur

Table 2. Interaction effect of different levels of N and S fertilizers with or without bio-fertilizer on nodulation and plant dry weight of Binamoog-6

Treatments	No of nodules $plant^{-1}$			Nodule dry weight (mg)			Plant dry weight (gm)		
	35 DAS	49 DAS	Harv. stage	35 DAS	49 DAS	Harv. stage	35 DAS	49 DAS	Harv. stage
$I_0N_0S_0$	16.52	27.90	10.50	30.80	52.08	20.80	1.26	2.09	11.24
$I_0N_0S_5$	17.33	30.12	11.80	32.02	55.20	21.40	1.29	2.12	11.43
$I_0N_0S_{10}$	25.42	39.17	14.50	50.30	79.20	35.30	1.62	2.45	12.10
$I_0N_{15}S_0$	20.50	33.62	12.90	42.50	62.50	26.60	1.41	2.24	11.77
$I_0N_{15}S_5$	18.66	30.71	12.30	35.80	59.80	22.92	1.33	2.16	11.65
$I_0N_{15}S_{10}$	21.25	37.32	13.05	46.50	68.23	30.50	1.47	2.32	11.95
$I_0N_{30}S_0$	8.33	11.60	5.65	15.90	23.30	13.80	0.85	1.71	8.28
$I_0N_{30}S_5$	12.17	19.70	8.20	21.50	40.50	17.70	1.05	1.88	10.72
$I_0N_{30}S_{10}$	15.23	24.90	9.90	27.81	49.80	19.80	1.18	2.01	10.86
$I_IN_0S_0$	30.95	52.55	19.18	66.80	85.30	38.20	1.56	2.95	14.49
$I_IN_0S_5$	35.45	58.53	21.90	75.50	101.20	47.30	2.11	3.40	14.70
$I_IN_0S_{10}$	41.45	62.13	23.20	83.60	115.4	49.80	2.39	3.75	15.08
$I_IN_{15}S_0$	25.13	36.8	17.16	60.90	76.9	35.06	1.23	2.55	11.32
$I_IN_{15}S_5$	28.65	41.10	18.09	62.30	80.80	35.80	1.51	2.60	11.43
$I_IN_{15}S_{10}$	33.45	57.25	20.52	70.50	95.60	40.50	1.84	3.05	14.58
$I_IN_{30}S_0$	13.60	20.07	9.95	26.10	38.30	18.30	0.95	1.53	9.05c
$I_IN_{30}S_5$	19.16	31.25	12.95	45.90	68.50	26.92	1.20	2.18	10.90
$I_IN_{30}S_{10}$	22.13	34.21	14.35	50.70	71.30	30.52	1.21	1.83	11.01
$LSD_{0.05}$	2.57	2.31	2.55	6.08	3.51	3.19	0.17	0.68	2.08

Plant dry weight: There was significant variation in the plant dry weight of inoculated and uninoculated Binamoog-6. The plant dry weight of Binamoog-6 recorded at 35 DAS, 49 DAS and harvest stage was significantly affected due to rhizobial inoculation (Table 1). Inoculated Binamoog-6 showed significant higher dry weight compared to that found in uninoculated Binamoog-6. The highest plant dry weight (12.51gm) was found in I_I (Inoculated) treatment at harvest stage and the lowest plant dry weight (1.27gm) was found in I_0 (Uninoculated) treatment at 35 DAS. The different levels of fertilizers and bio-fertilizer showed significant variation in plant dry weight and the application of *Bradyrhizobium* significantly increases the plant dry weight. The highest plant dry weight (13.59gm) was found in N_0S_{10} treatment at harvest stage which was statistically similar of that found in $N_{15}S_{10}$ treatment (13.26gm) and the lowest 0.90 gm was found in $N_{30}S_0$ treatment at 35 DAS (Table 1). The interaction effect of different levels of fertilizers with or without bio-fertilizer was significantly affected at 1% level of significance. The highest number of nodule (62.13) was found in $I_IN_0S_{10}$ treatment at 49 DAS and the lowest number (5.65) was found in $I_0N_{30}S_0$ treatment at harvest stage. The highest nodule dry weight (115.40) mg was found in $I_IN_0S_{10}$ treatment at 49 DAS and the lowest weight (13.80) mg was found in $I_0N_{30}S_0$ treatment at harvest stage (Table 2). Sattar and Ahmed (1995) reported the similar result that *Bradyrhizobium* inoculation increased total nodules and also nodule dry weight significantly on mung. On the other hand the highest plant dry weight (15.08gm) was found in $I_IN_0S_{10}$ treatment at harvest stage and the lowest weight (0.85gm) was found in $I_0N_{30}S_0$ treatment at 35DAS (Table 2). Gupta *et al* (1988) conducted experiment with soybean and reported similar results.

From the present study, it may be concluded that Binamoog-6 significantly responded to combined use of different levels of nitrogen and sulphur fertilizers with or without bio-fertilizer. Inoculation of *Bradyrhizobium* significantly increased the nodulation and plant growth of Binamoog-6. However, further trials may be conducted at different agro-ecological zones to decide the exact dose of nitrogen and sulphur fertilizers with bio-fertilizer in a specific area of Bangladesh.

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