Welcome to

Nuclear aided Legume Nitrogen Research in Bangladesh

Location of Bangladesh

Bangladesh

Location BINA, Mymensingh

Mymensingh

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LEGUME NITROGEN DERIVED FROM DIFFERENT SOURCES AS AFFECTED BY RHIZOBIAL INOCULANT IN BANGLADESH SOIL

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Significance

Managing N in crop production systems to achieve economic and environmental sustainability is a major challenge facing agriculture.

Relying less on commercial fertilizer N and more on biological N_2 fixation by legumes has been suggested as a way to meet this challenge (Keeney, 1982).

Declining soil fertility, particularly N, is the recognized as a major threat to continued rice/cereal cropping in Bangladesh soil.

One proposal to overcome declining N fertility in this region is the incorporation of a legume crop into the cropping system in order to provide N for subsequent cereal/rice crops

Among the food crops, legumes (especially pulses) are important Crops in Bangladesh and occupy an area of about 0.69 million ha (5.50% of the total cropped area) and contribute about 2.19% of the total grain of the country.

Legumes are superior green manure crops compared to non-Leguminous crops because they fix atmospheric nitrogen (N).

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Biologically N fixing system offers an economically attractive and ecologically sound means of reducing external inputs of industrial N fertilizers and improving internal resources.

By using ^{15}N tracer, rhizobial inoculants demonstrated the significant contribution of atmospheric N_2 fixation to legume nutrition and growth and a quantitative evaluation of N derived from different sources.

However, in Bangladesh, yet there is still a lack of information on actual quantities of N in legumes contributed from different sources.

Therefore, keeping the above points in view, the present study has been undertaken to achieve the following objectives:

Research Objectives

Objective (s):

1. To know the effect of rhizobial inoculant on N fixation in different legumes.

2. To quantify the fixed N in legumes derived from different sources

3. To estimate the amount of atmospheric N_2 fixed in different legumes with and without inoculant

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Materials and Methods

Location : BINA sub-station farm Rangpur

- **AEZ : Tista Meander Floodplain Soil**
- **Latitude:$25^0$43’ N and Longitude: 89^0 16’ E**

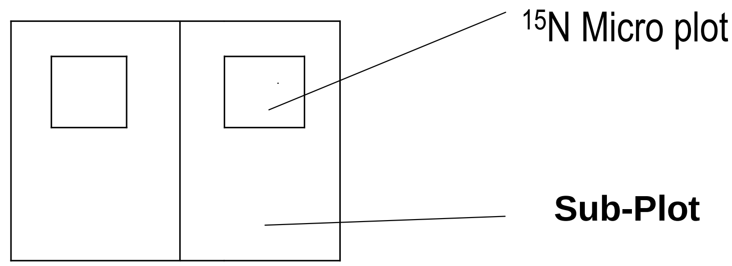
Design: RCBD 2 factor (Split Plot)

Plot size:

- **Sub-plot = 5m x 3m**
- **Isotopic micro-plot = 1mx1m**

- **For isotopic study ^{15}N ammonium sulphate 10.48% a.e. was used in each of the isotopic micro plot.**

^{15}N isotope plot technique



Treatment Descriptions:

Factor-1: Legume type (3 Nos.)

L_1 = Lentil (*Lens culinaris,* Medik)

L_2 = Mungbean (*Vigna radiata*)

L_3 = Soybean (*Glycine max*, L. Marr)

contd.

Factor-2: Rhizobial inoculant

- **I_0 = Without inoculant**
- **I_1 = With inoculant**

For symbiotic N fixation study a non nodulated crop (wheat) was included in a separate plot as reference

contd.

Different Rhizobial strains used in the study:

Lentil: Mixture of BINA-634, BINA-40 and BINA-630

Mungbean: Mixture of BINA-441, BINA-69 and THA-301

Soybean: Mixture of BINA-120 and BINA-1906

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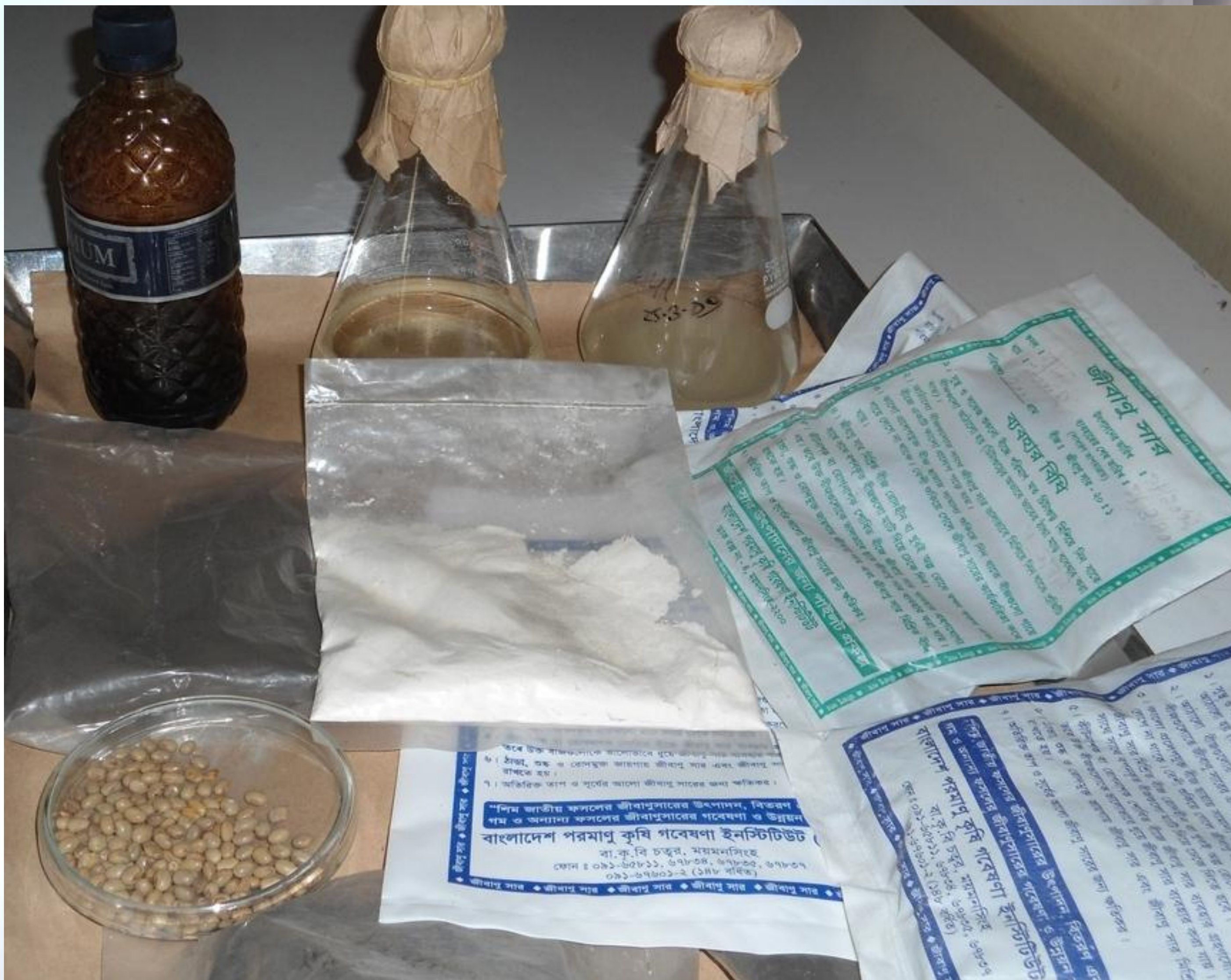

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Tools for BNF Quantification

^{15}N dilution method:

The isotope dilution method is dependent on the comparison of a fixing and non-fixing system. N in fixing plant derives from soil, fertilizer and air, while in non-fixing plant, soil and fertilizer only.

The isotope dilution method offers an accurate integrated measure of dinitrogen fixation in biological system

(Rennie et al., 1978).

Photo 1. The ^{15}N emission spectrometer NOI 7

Quantification of N sources (IAEA, 1990):

a. Ndff (N derived from fertilizer)
= {(% ^{15}N a.e. plant sample) / (% ^{15}N a.e. labelled fertilizer) x 100}

b. Ndfs (N derived from soil)
= 100 - % Ndff

c. Ndfa (N derived from atmosphere)
= { 1 – (%^{15}Na.e. F)/(%^{15}Na.e. NF) x 100}

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Results

Table 1. Physical characteristics of initial soil (30cm depth)

Sl. No.	Soil Characteristics (Physical)	Value
1.	Mechanical fractions (USDA system)	
	a. Sand (0.2 - 0.02mm)	37%
	b. Silt (0.02 - 0.002mm)	52%
	c. Clay (< 0.002 mm)	15%
2.	Textural class	Silty loam
3.	Bulk density (gm^{-1})	1.29
4.	Water holding capacity	47.2%

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Table 2. Chemical characteristics of initial soil (30cm depth)

Sl. No.	Soil Characteristics (Chemical)	Value
1.	Organic Carbon	0.73%
2.	Cation exchange capacity (cmol kg^{-1})	10.1
3.	Soil pH	7.2
4.	Total N	0.074 %
5.	Exchangeable K (cmol kg-1)	0.12
6.	Available P (mg kg^{-1})	5.03
7.	Available S (mg kg^{-1})	8.71

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Nodulation

Table 3. Nodulation as affected by different legumes and inoculant (Interaction effect).

Legume	Inoculant	Nd. no. pl^{-1}	Nd. dry wt. (mg pl^{-1})
Lentil	Uninoculated	8.10c	5.47e
	Inoculated	15.4b	13.54d
Mungbean	Uninoculated	8.20c	24.56c
	Inoculated	14.30b	55.33b
Soybean	Uninoculated	2.60c	13.38d
	Inoculated	33.40a	190.51a

Yield of Legumes

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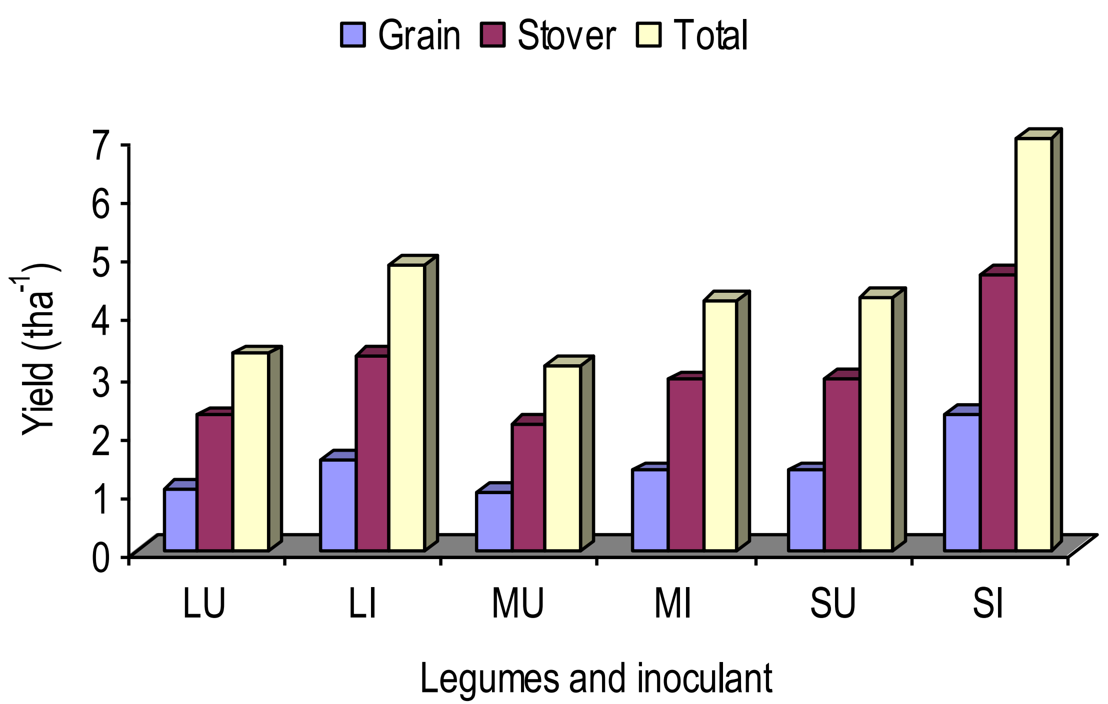

Fig. 1. Grain, stover and total yield of legumes as affected by inoculation (Grain yield increased: L = 44.04, M = 41.25 & S = 69.35%)

% N in Legumes

Table 4. % Nitrogen in different Legumes with and without inoculant

Legume	Inoculant	Seed N	Stover N	Total N
Lentil	Uninoculated	3.14	1.18	1.82
	Inoculated	4.12	1.27	2.18
Mungbean	Uninoculated	2.87	1.12	1.70
	Inoculated	3.60	1.23	1.98
Soybean	Uninoculated	5.11	1.25	2.49
	Inoculated	5.38	1.87	3.12

N Yield in Legumes

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Table 5. Nitrogen yield (kgha^{-1}) in seed and stover of different Legumes with and without inoculant (Interaction effect).

Legume	Inoculant	Seed N yield	Stover N yield
Lentil	Uninoculated	26.46e	20.64c
	Inoculated	50.09c	33.42b
Mungbean	Uninoculated	22.96e	18.09c
	Inoculated	40.48d	29.69b
Soybean	Uninoculated	63.17b	32.42b
	Inoculated	112.65a	76.99a

Table 6. Total N yield in different legumes (kgha^{-1}) with and without inoculant

Legume	Inoculant	Total N yield
Lentil	Uninoculated	47.10e
	Inoculated	83.52c
Mungbean	Uninoculated	41.04e
	Inoculated	70.16d
Soybean	Uninoculated	95.59b
	Inoculated	189.64a

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Quantification of N derived from different sources

N derived from atmosphere (Ndfa)

Table 6. Nitrogen derived from atmosphere (Ndfa) in seed and stover of different legumes ($kgha^{-1}$) with and without inoculant

Legume	Inoculant	Seed Ndfa	Stover Ndfa
Lentil	Uninoculated	17.59d	13.29e
	Inoculated	41.87b	27.26b
Mungbean	Uninoculated	14.75d	11.18e
	Inoculated	33.03c	23.61c
Soybean	Uninoculated	34.36c	16.78d
	Inoculated	95.51a	64.12a

Table 7. Total Nitrogen derived from atmosphere (Ndfa) in different legumes (kgha^{-1}) with and without inoculant

Legume	Inoculant	Total Ndfa
Lentil	Uninoculated	30.88e
	Inoculated	69.13b
Mungbean	Uninoculated	25.92f
	Inoculated	56.64c
Soybean	Uninoculated	51.13d
	Inoculated	159.62a

N derived from soil
(Ndfs)

Table 8. Nitrogen derived from soil (Ndfs) in seed and stover of different legumes (kgha^{-1}) with and without inoculant

Legume	Inoculant	Seed Ndfs	Stover Ndfs
Lentil	Uninoculated	6.81c	5.72c
	Inoculated	6.32c	4.80e
Mungbean	Uninoculated	6.31c	5.37c
	Inoculated	5.73c	4.71d
Soybean	Uninoculated	22.14a	12.15a
	Inoculated	13.17b	10.01b

Table 9. Total Nitrogen derived from soil (Ndfs) in different legumes (kgha^{-1}) with and without inoculant

Legume	Inoculant	Total Ndfs
Lentil	Uninoculated	12.53c
	Inoculated	11.12c
Mungbean	Uninoculated	11.68c
	Inoculated	10.44c
Soybean	Uninoculated	34.29a
	Inoculated	23.18b

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N derived from fertilizer (Ndff)

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Table 10. Nitrogen derived from fertilizer (Ndff) in seed and stover of different legumes (kgha^{-1}) with and without inoculant

Legume	Inoculant	Seed Ndff	Stover Ndff
Lentil	Uninoculated	2.05c	1.64c
	Inoculated	1.89d	1.37c
Mungbean	Uninoculated	1.90d	1.55c
	Inoculated	1.73d	1.36c
Soybean	Uninoculated	6.68a	3.50a
	Inoculated	3.97b	2.87b
CV (%)			

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Table 11. Total Nitrogen derived from fertilizer (Ndff) in different legumes ($kgha^{-1}$) with and without inoculant

Legume	Inoculant	Total Ndff
Lentil	Uninoculated	3.68c
	Inoculated	3.27c
Mungbean	Uninoculated	3.44c
	Inoculated	3.08c
Soybean	Uninoculated	10.17a
	Inoculated	6.85b

Comperative amount of N derived from different sources

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Table 12. Comparative amount of Total N and Total Ndfa in different legumes with and without inoculant .

Legume	Inoculant	Total N	Total Ndfa ($kgha^{-1}$)	Total Ndfa (%)
Lentil	Uninoculated	47.10e	30.88e	65.56
	Inoculated	83.52c	69.13b	82.77
Mungbean	Uninoculated	41.04f	25.92f	63.15
	Inoculated	70.16d	56.64c	80.72
Soybean	Uninoculated	95.59b	51.13d	53.48
	Inoculated	189.63a	159.62a	84.17

Table 13. Comparative amount of Total N and Total Ndfs in different legumes with and without inoculant .

Legume	Inoculant	Total N	Total Ndfs	Total Ndfs (%)
Lentil	Uninoculated	47.10e	12.53c	26.60
	Inoculated	83.52c	11.12e	13.31
Mungbean	Uninoculated	41.04f	11.68d	28.46
	Inoculated	70.16d	10.44e	14.88
Soybean	Uninoculated	95.59b	34.29a	35.87
	Inoculated	189.63a	23.18b	12.22

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Table 14. Comparative amount of Total N and Total Ndff in different legumes with and without inoculant .

Legume	Inoculant	Total N	Total Ndff	Total Ndff (%)
Lentil	Uninoculated	47.10e	3.68c	7.81
	Inoculated	83.52c	3.27c	3.91
Mungbean	Uninoculated	41.04f	3.44c	8.55
	Inoculated	70.16d	3.08c	8.38
Soybean	Uninoculated	95.59b	10.17a	10.64
	Inoculated	189.63a	6.85b	3.61

Fig. 4. Total N and their sources as affected by different legumes and inoculant

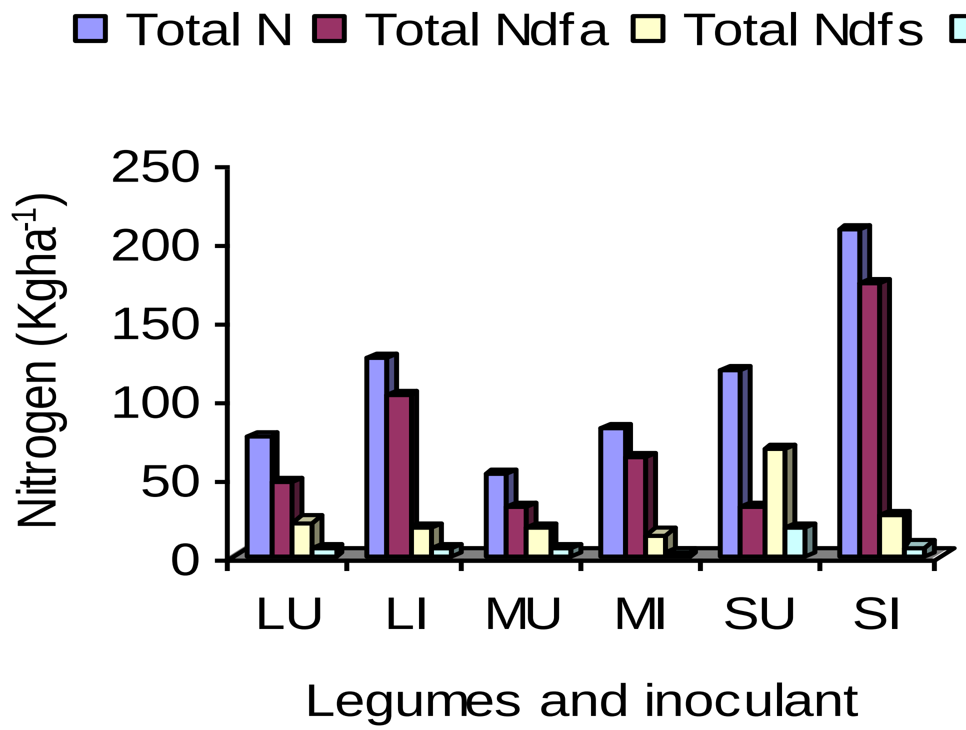

Table 14. Comparative amount ($kgha^{-1}$) of N derived from different sources in legumes under inoculated situation

Legume	Total Ndfa	Total Ndfs	Total Ndff
Lentil	69.13	11.12	3.27
	(82.77%)	(13.31%)	(3.27%)
Mungbean	56.64	10.44	3.08
	(80.72%)	(14.88%)	(4.40%)
Soybean	159.62	23.18	6.85
	(84.17%)	(12.22%)	(3.61%)

Conclutions

Among the different sources of N in legumes, the maximum portion of N fixed from the atmosphere source, specially under inoculated situation (80-84%), whereas, from soil and fertilizer sources, the percent of N derived only 12-14 and 3 - 4%, respectively.

The inoculated soybean was the best fixer (Total Ndfa = 84.17%, equivalent to 159.62 kg Nha^{-1}). This would represent a substantial input of N into any farming system.

Next was the inoculated lentil (Total Ndfa = 82.77%; equivalent to 69.13 kg Nha^{-1}), While the inoculated mungbean was the lowest N fixer being total Ndfa was 80.72%; equivalent to only 56.63 kg Nha^{-1}.

The study clearly indicated that there is a ample scope for increasing production level through improved N fixation by inoculation in different legumes (soybean = 69.35%, lentil = 44.04% and mungbean = 41.25%).


Thankyou all