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Effect of *Bradyrhizobium* Inoculum at Different Nitrogen Levels on Summer Mungbean

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Abstract: Experiment was conducted to study the effect of *Bradyrhizobium* inoculation at different nitrogen levels viz. 0, 20, 40, 60 and 80 kg N ha^{-1} on Binamoog-2. *Bradyrhizobium* inoculation increased dry matter production, nodulation, pod production, seed yield, harvest index and benefit cost ratio. Nitrogen negatively affected on nodulation and harvest index. Increase of nitrogen fertilizer increased seed yield up to 40 kg N ha^{-1} and straw yield up to 60 kg N ha^{-1}. Highest seed yield (1607 kg ha^{-1}) and benefit cost ratio (2.35) obtained when 40 kg N ha^{-1} was applied with *Bradyrhizobium* inoculation.

Key wards: *Bradyrhizobium*, inoculum, nitrogen, summer mungbean

Introduction

Mungbean (*Phaseolus Mungo* L.) is one of the important pulse crops in Bangladesh which ranks fifth among the pulses both in acreage and production (Anonymous, 1994). It can be cultivated both in summer and winter (Bose, 1982). In Bangladesh, mungbean gave the highest yield when it was sown on March 15 (Karim *et al*., 1988). Binamoog-2 is a summer mungbean variety developed by Bangladesh Institute of Nuclear Agriculture (BINA) in 1994. Nitrogen is an important major nutrient element for plant. For legume, it is more useful because it is the main component of amino acid as well as protein. Adequate supply of nitrogen is essential for normal growth and yield. In Bangladesh, most of the lands are deficient in organic matter and nitrogen. To fulfil the demand of nitrogen usually urea and ammonium sulfate are being used. These chemical fertilizers are costly and detrimental to the environment. Otherwise Rhizobium can fix atmospheric di-nitrogen by symbiosis process with leguminous plants and make available to the plant. Scientists of BINA has been isolated some *Bradyrhizobium* strains for mungbean. To reduce the production cost and to fulfil the demand, more pulse production could be achieved through seed inoculation with *Bradyrhizobium* bio-fertilizer that is known to influence nodulation, biological nitrogen fixation, growth and yield of pulses. Available literature showed that *Bradyrhizobium* inoculation increased seed yield from 4.3 to 162% (Vaishya *et al*., 1983). Inoculation with Rhizobium biofertilizer increased 57% effective nodule, 77% dry matter production, 64% grain yield and 40% hay yield over control (Chanda *et al*., 1991). Maximum yield was obtained when fertilizers were applied together with Rhizobium inoculation (Bali *et al*., 1991). In Bangladesh several repots have been published on winter mungbean but no reports has been found on the response of both N and *Bradyrhizobium* biofertilizer on summer mungbean especially in Binamoog-2. Considering the above facts, this study was undertaken to I) find the effect of nitrogen and *Bradyrhizobium* on Binamoog-2 ii) identify the optimum level of nitrogen with *Bradyrhizobium* inoculation for higher yield and profit.

Materials and Methods

The experiment was laid out in a split plot design with three replications assigning *Bradyrhizobium* inocula in main plots and nitrogen in sub plots at the Agronomy field Laboratory, BAU, Mymensingh during March to June, 1994. A liquid mixture of three *Bradyrhizobium* inocula i.e. BfNA MB 441, BINA MB 169,BfNA MB 301 and five levels of nitrogen i.e. 0, 20, 40, 60 and 80 kg-N ha^{-1} were included in the experiment. The unit plot size was 4.0x2.5M2 . Fertilizers were applied @ 60 kg $P_2 0_5$ and 30kg $K_2 0$ from triple super phosphate and muriate of potash respectively. Liquid mixture of three *Bradyrhizobium* inocula was mixed with the seeds before sowing and nitrogen was applied in the form of urea following the treatments of the experiment at the time of fertilizer application. Seeds were sown on March 12, 1994 maintaining 40 cm line to line and 10 cm plant to plant spacing. Data on nodulation and dry matter production was collected at 60 days after sowing. At 80% maturity of pods, the crop was harvested on June 12, 1994 and data on plant height, number of branch/plant, number of pods $plant^{-1}$, number of seeds pod^{-1}, 1000 seeds weight, seed and straw yield etc. were taken and subjected to statistical analysis following the M-stat programme. Duncan's multiple range test was done as and when necessary.

Results and Discussion

Application of *Bradyrhizobium* inocula showed significant effect on nodulation, pod production, seed yield, harvest index and benefit cost ratio (Table 1). Inoculation did not affect on days to flowering, plant height, number of branch, % of mature pods, number of seeds pod^{-1}, % of grain filling, 1000-seeds weight and straw yield. Excessive nitrogen delayed flowering. Dry matter production increased up to 60 kg Nha^{-1}.

Inoculation did not showed significant effect on flowering and dry matter production while nitrogen fertilizer had significant effect on both flowering and dry matter productions. Excessive nitrogen delayed flowering but dry matter production was increased up to 60 kg Nha^{-1} (Table 2). Earlier flowering (33.3 DAS) was observed at 20 kg Nha^{-1} with inoculation and it was delayed (39.0 DAS) when 80 kg Nha^{-1} was applied with inoculation (Table 3). Maximum dry matter (37.5 g plant^{-1}) was obtained when 40 kg Nha^{-1} was applied with inoculation and it was minimum (25.9 g plant^{-1}) in control (0 kg Nha^{-1} without inoculation).

Bradyrhizobium inoculation significantly affected nodulation of mungbean. Results showed that significantly higher number of nodule (20.0) and weight of nodule (146 mg) per plant were recorded when inoculated with *Bradyrhizobium* compared to uninoculated (14.73, 58 mg) plant (Table 1). Nodulation decreased with the increase of nitrogen rate. This result was similar with the result of Patel *et al.* (1985) and Chanda *et al.* (1991). Vaishya *et al.* (1983) reported that Rhizobium inoculation generally initiated the early nodule formation in the crown root system so that nodulation was better in inoculated plants. Data showed that nitrogen fertilizer adversely affected nodulation (Table 2). The number and weight of nodule was higher (24.16, 175 mg plant^{-1}) when no nitrogen was applied followed by 20 kg N ha^{-1} (21.83, 133 mg plant^{-1}) while it was lower (11.71/48 mg plant^{-1}) at 80 kg N. This trend of nodule production was found in an experiment of Thayumanavan and Sadasivarn (1989).

The interaction effect of inoculum and nitrogen was significant in respect of nodulation. Maximum number (25.0) and dry weight of nodule (243 mg) plant^{-1} were obtained from *Bradyrhizobium* inoculated plants without nitrogen and it was minimum (9.67, 17 mg) in uninoculated plants at 80 kg Nha^{-1} (Figs. 1, 2).

In case of inoculation, plant produced bigger size of nodules, which resulted in maximum weight of nodules (Panwar *et al.*, 1988). This might be due to the earlier nodulation in lower level of nitrogen with inoculum and higher percentage of effective nodules plant^{-1}. The decrease of nodulation in higher levels of nitrogen might be the cause that legumes do not allow the respective *Bradyrhizobium* to infect their root system for nodulation of available nitrogen is present in that particular soil.

Plant height did not significantly differ by inoculation with *Bradyrhizobium*. In case of nitrogen application plant height differed significantly which was similar to the findings of Mand and Chahal (1987) that plant height increased with the increase of nitrogen rate. Highest plant height (75.1 cm) was found at 80kg N ha^{-1} and it was lowest in control (0 kg Nha^{-1}). Interaction effect of nitrogen and inoculation did not differ significantly in respect to plant height.

Number of branch plant^{-1} was not significantly different in inoculated or uninoculated plants. Number of branch increased statistically with increase of nitrogen fertilizer up to 60 kg Nha^{-1} and then decreased. Plant produced maximum number of branch (6.77 plant^{-1}) at 60 kg Nha^{-1} with *Bradyrhizobium* inoculation and it was minimum at 0 kg Nha^{-1} with inoculation.

Bradyrhizobium inoculated plant produced significantly higher number (40.8) of pods plant^{-1} in compared to uninoculated (35.5) plants. Number of pods plant^{-1} increased with the increase of nitrogen fertilizer up to a certain limit. Maximum number of pods plant^{-1} (42.2) obtained when 60 kg Nha^{-1} was applied with *Bradyrhizobium* and it was lowest (31.7) in absolute control. Percentage of mature pods did not affect with nitrogen application (Table 1, 3).

Number of seeds pod^{-1} and % of filled seeds did not affect significantly with inoculation or nitrogen rate (Table 4 and 5). Interaction effect of nitrogen and inocula was also statistically different in respect to number of gain pod^{-1} and similar to the rate of grain filling. Sixty kg Nha^{-1} plus inoculation gave maximum number of grains pod^{-1} (12.3) and it was minimum (10.2) at 80 kg Nha^{-1} with inoculation (Table 6).

Table 1: Effect of *Bradyrhizobium* inocula on flowering, nodulation, dry matter pod production of Binaoog -2

Treatments	Days to flowering	Dry matter wt.(g plant^{-1}) (at 60 DAS)	No. of nodule plant^{-1}	Wt. of dry nodule (mg plant^{-1})	Plant height (cm)	No. of branch plant	No.of pods plant^{-1}	%of mature pods
Inoculated (1)	35.2	35.0	20.00	146	73.0	6.19	40.8	68.1
Un-inoculated(l)	35.3	32.7	14.73	58	70.2	6.24	35.5	68.3
SE	0.21	0.897	1.027	11.165	0.945	0.138	1.263	0.998
Sig.	NS	NS	*	**	NS	NS	*	NS
CV%	3.53	6.85	23.07	30.48	8.91	8.42	10.70	7.36

*= and **= significant at 5% and 1% level, respectively, NS =not significant

Table 2: Effect of nitrogen fertilizer on flowering, nodulation, dry matter and pod production of Binamoog-2

Treatments	Days to flowering	Dry matter wt.(g plant^{-1})	No. of nodule plant^{-1}	Wt. of dry nodule (mg plant^{-1})	Plant height (cm)	No. of branch plant	No.of pods plant^{-1}	%of mature pods
N_0 (control	36.3b	27.5d	24.16a	175a	68.8c	5.40b	34.2c	67.7
N_1 (20 kg-N ha^{-1})	34.5b	32.9c	21.83b	133b	70.3c	6.25a	38.1b	68.8
N_2 (40 kg -N ha^{-1})	34.3b	35.8b	16.33c	85c	70.9c	6.55a	40.8a	68.0
N_3 (60 kg-N ha^{-1})	34.1b	36.5a	13.33c	68c	72.9b	6.60a	39.3ab	68.5
N_4 (80kg-N ha^{-1})	37.2a	36.4a	11. 17d	48d	75. la	6.28a	38.2b	68.0
SE	0.543	0.954	1.437	12.041	1.542	0.213	1.703	1.858
Sig.	*	**	**	**	*	*	**	ns
CV%	3.53	6.85	23.07	30.48	8.91	7.36	11.42	7.36

Table 3: Interaction effect of varieties and nitrogen on flowering,, nodulation dry matter and pod production of Binamoog-2

Treatments	Days to flowering	Dry matter (at 60 DAS) (g plant^{-1})	Plant height (cm)	No. of branch plant^{-1}	No.of pods plant^{-1}	%of mature pods
IN_0	35.0c	29.2	67.3	5.33	36.7	68.0
IN_1	33.3d	35.2	71.1	6.20	42.1	68.7
IN_2	34.3c	37.5	72.3	6.57	44.0	68.3
IN_3	34.6c	36.4	75.6	6.77	42.2	68.3
IN_4	39.0a	36.7	78.7	6.10	38.9	67.3
I0N0	37.7b	25.9	70.3	5.47	31.7	67.3
I_0N_1	35.7bc	30.7	69.5	6.30	34.0	69.0
I_0N_2	34.3c	33.9	69.5	6.53	37.7	67.7
I_0N_3	33.73	36.7	70.2	6.43	36.4	68.7
I_0N_4	35.3bc	36.1	71.5	6.47	37.6	68.7
SE	0.769	1.349	2.182	0.302	2.409	2.627
Sig.	*	NS	NS	NS	NS	NS
CV%	3.53	6.85	8.91	8.42	10.70	7.36

Table 4: Effect of Bradyr izobium inocula o yield andyield attributes of Binamoog-2

Treatments	No of seeds pods^{-1}	% of filled seed	1000 seeds wt. (g)	seed yield (g plant^{-1})	seed yield (kg ha^{-1})	straw yield (kg ha^{-1})	Harvest index (%)	Benefit cost ratio (BCR)
Inoculated (1)	11.3	87.5	30.87	6.95	1501	4004	27.61	2.23
Uninoculated (1_0)	11.0	89.5	30.72	6.42	1366	3851	26.34	2.07
SE	0.055	0.857	0.138	0.067	25.89	106.07	0.452	0.038
Sig.	ns	ns	ns	*	**	ns	**	*
CV%	3.64	5.24	2.45	5.38	5.62	6.06	6.00	4.56

Table 5: Effect of nitrogen on yield and yield attributes of Binamoog -2

Treatments	No of seeds pods^{-1}	% of filled seed	1000 seeds wt. (g)	seed yield (g plant^{-1})	seed yield (kg ha^{-1})	straw yield (kg ha^{-1})	Harvest index (%)	Benefit cost ratio (BCR)
N_0 (control)	10.9	99.0	30.6lb3	6.29c	1335c	3237d	29.28a	2.05
N_1 (20 kg -N ha^{-1})	11.0	91.2	0.59b	6.56b	1435b	3618c	28.48a	2.18
N_2 (40kg-N ha^{-1})	11.4	88.5	31.25a	7.08a	1495a	3815b	28.21a	2.23
N_3 (60kg-N ha^{-1})	11.7	86.5	30.89ab	6.93a	1498a	4586a	24.52b	2.22
N_4 (80kg-N ha^{-1})	10.8	86.8	30.63b	6.53b	1416b	4383a	24.39b	2.07
SE	0.169	1.902	0.301	0.140	30.30	100.3	0.606	0.037
Sig.	ns	ns	*	**	**	**	**	ns
CV%	3.64	5.24	2.45	5.38	5.62	6.06	6.00	4.56

Table 6: Interaction effect of inocula X nitrogen on yield and yield attributes on Binamoog-2

Treatments	No of seeds pods^{-1}	% of filled seed	1000 seeds wt. (g)	seed yield (g plant^{-1})	straw yield (kg ha^{-1})	Harvest index (%)	Benefit cost ratio (BCR)
IN,	11.2ab	90.3	30.22	6.79	3362	30.47a	2.21a
IN,	11.1ab	91.0	31.00	6.95	3602	29.92a	2.27a
IN2	11.8a	85.3	31.01	7.41	3819	29.78a	2.35a
IN3	12.3a	85.3	31.12	7.03	4724	24.17de	2.23a
N	10.2c	85.3	31.01	6.54	4511	23.47e	2.06ab
I,N,	10.6be	87.7	31.01	5.79	3112	28.10ab	1.89b
IoN 1	10.8b	91.3	30.18	6.18	3634	27.05b	2.08ab
ION2	10.9b	91.6	31.49	6.75	3811	26.64bc	2.10ab
ION3	11.0ab	87.7	30.67	6.84	4448	24.88bc	2.22a
ION4	11.4ab	88.3	30.24	6.51	4254	25.05cd	2.09ab
SE	0.239	2.691	0.425	0.198	141.4	0.858	0.053
Sig.	*	ns	ns	ns	ns	*	*
CV%	3.64	5.24	2.45	5.38	6.06	6.00	4.56

Means followed by the same letter (s) did not differ significantly at 5%level of probability
*= and **= significant at 5%and 1% respectively, NS =not significant

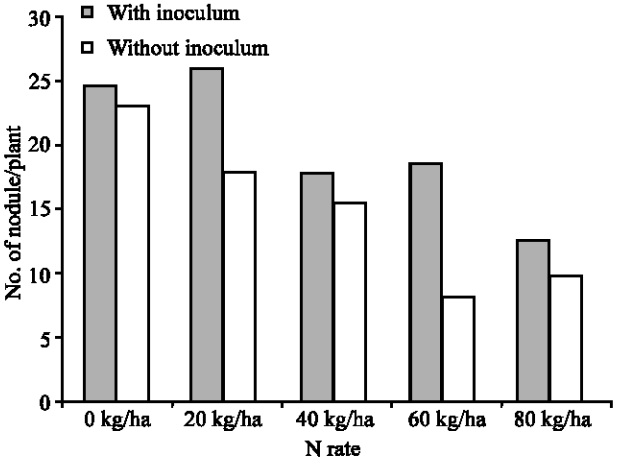

Fig. 1: Nodule production of mungbean at different N level

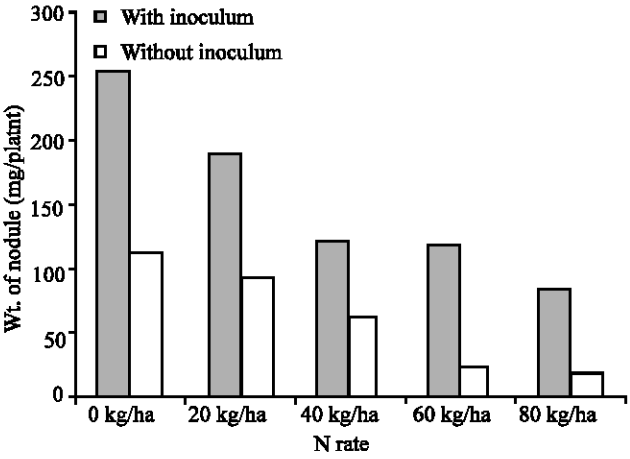

Fig. 2: Nodule production of mungbean at different N levels

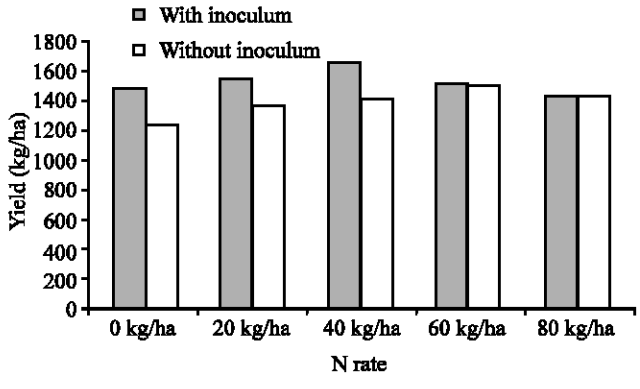

Fig. 3: Effect of N and inoculum on the yield of mungbean

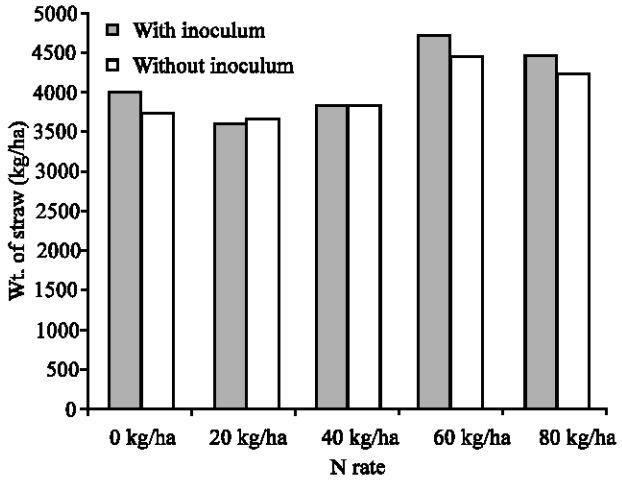

Fig. 4: Effect of N and inoculum on straw production of mungbean

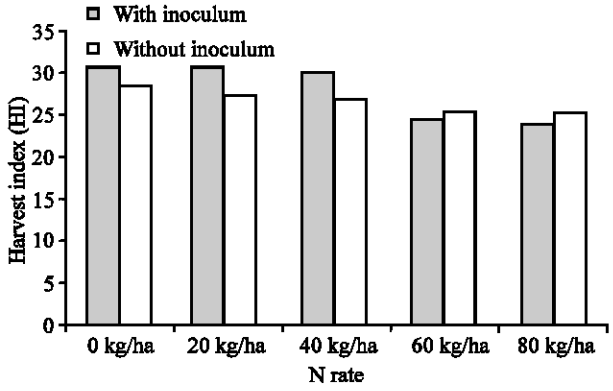

Fig. 5: Effect of N and inoculum on HI on mungbeab

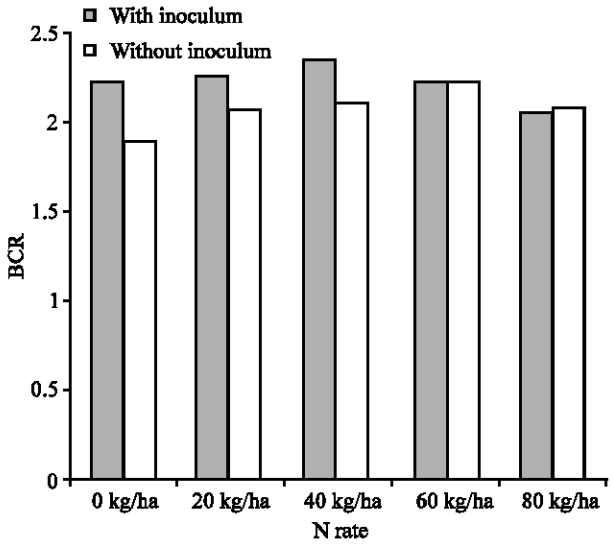

Fig. 6: BCR at different N levels

Thousand seeds weight was statistically similar with or without *Bradyrhizobium* inoculation but dissimilar with different nitrogen rates (Table 4, 5). Significantly higher seed yield (6.95 g plant^{-1} and 1501 kg ha^{-1}) was obtained from *Bradyrhizobium* inoculated and it was lower (6.42 g plant^{-1} and 1366 kg ha^{-1}) in un-inoculated plants. Higher number and percentage of mature pod number of grains, gain-filling rate might be the higher (11%) seed yield in inoculated plants. These results were similar with the findings of Prasad and Ram (1988) that inoculation significantly increased seed yield of mun bean. Nitrogen fertilizer increased seed Yield of mungbean. Nitrogen fertilizer increased seed Yield up to 40 Kg N ha^{-1} (I 607 kg ha^{-1}) with inoculation and up to 60 Kg N ha^{-1} (13 82 Kg ha^{-1}) without inoculation (Fig. 3). Maximum seed yield (7.41g plant^{-1} or 1607 Kg ha^{-1}) was obtained from *Bradyrhizobium* inoculated plants at 40 Kg N ha^{-1} while it was minimum (5.79 g plant^{-1} or 1212 Kg ha^{-1}) at 0 Kg N ha^{-1} without inoculation (Fig. 3). This result seems to be similar to the result of Prasad and Ram (1988). The increase of seed yield with the influence of inoculation without nitrogen was maximum (about 20.3% at 0 kg Nha^{-1}) in lower nitrogen rates and it was decreased (2.84% at 80 kg Nha^{-1}) with the increase of nitrogen rate over uninoculated control. The average seed yield (1433.5 kg ha^{-1}) was higher than the national average yield of mungbean (453 kg ha^{-1}) (Anonymous, 1994) might be the result of proper agronomic management, use of high yielding variety (Binamoog-2), *Bradyrhizobium* inoculation and optimum sowing time.

Nitrogen fertilizer showed significant effect on straw production of mungbean (Fig. 4). Maximum (4724 kg ha^{-1}) straw was obtained at 60 kg Nha^{-1} with inoculation and it was minimum (3112 kg ha^{-1}) in absolute control (Table 4). This result was similar with the report of Mand and Chahal (1987), Leelavati *et al.* (1991) and Chanda. *et al.* (199 1).

Bradyrhizobium significantly increased harvest index HI (Fig. 5) and benefit cost ratio (BCR) which conforms the report of Gill *et al.* (1985). Harvest index decreased with the increase of nitrogen fertilizer might be due to influence of vegetative growth and increased straw yield reduced harvest index. Maximum harvest index (30.47%) observed at 0 kg N ha^{-1} with *Bradyrhizobium* inoculation while it was minimum (23.47%) at 80 kg N ha^{-1} with inoculation. Benefit cost ratio did not influence significantly with different doses of nitrogen but differed its interaction with inoculation. Maximum BCR (2.35) obtained from, the treatment of 40 kg N ha^{-1} with *Bradyrhizobium* inoculation where as it was lowest (1.89) in control (Fig. 6).

From the present investigation it could be concluded that 40 kg N ha^{-1} with *Bradyrhizobium* inoculation was the most suitable and profitable dose of nitrogen for old Brahmaputra terrace soil (BAU Campus).

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