Original Research Article

Influence of Nitrogen levels and Biofertilizers on the growth and yield of French bean (*Phaseolus vulgaris* L.)

ABSTRACT

The field experiment entitled "Influence of Nitrogen levels and Biofertilizers on the growth and yield of French bean" was conducted during *rabi* season, 2022 at Crop Research Farm in the Department of agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj Uttar Pradesh. The treatment consisted of three levels of Nitrogen (75, 100 and 125 kg/ha), Biofertilizers (*Rhizobium*, PSB and *Rhizobium* + PSB) and control. The experiment was layout in Randomized Block Design (RBD) with 10 treatments and replicated thrice. Application of *Rhizobium* and PSB along with Nitrogen 100 kg/ha produces higher plant height (46.19cm), higher dry weight (26.20g), maximum number of pods/plant (19.73), maximum number of seeds/pod (5.08), seed yield (22.47 q/ha) and stover yield (50.08 q/ha).

Keywords: French bean, Nitrogen, Biofertilizer, growth and yield.

Introduction

French bean (*Phaseolus vulgaris* L.) is one of the most important commercially grown pulse crop globally. This crop is well adopted to diverse climatic conditions ranging from tropical to temperate region. The French bean (*Phaseolus vulgaris* L.) is a short duration high yielding legume plant of family Fabaceae known by common bean or kidney bean and was considered to have been introduced from Ethiopia in the 16th century by the Portuguese. It is one of the most important commercially grown legume crops during winter season in India and it can be used both as pulse and vegetable. Seed of French bean is highly nutritious containing 22.90 percent protein, 1.20 percent fat and 60.60 percent carbohydrates and minerals viz. calcium (260 mg/100 g of seed), phosphorus (101 mg/100 g of seed) and iron (5.80 mg/100 g of seed). It is assumed that beans can play an important role in the enhancement of the level of nourishment because this plant

is rich in elements like potassium, calcium, iron and phosphorus and it contains 18-32 percent of protein in every grain averagely. The plant is also rich in vitamins like A, B and D etc.

French bean is considered as a nitrogen responsive crop due to its high responsiveness to fertilizer while it is noticed that increased nutrition has a negative impact on yield. Nitrogen is so vital in every crop because it is a major component of chlorophyll, amino acids and the building blocks of proteins. Without proteins, plants wither and die. Application of N increases leaf N and chlorophyll content. Leaf N, chlorophyll and photosynthetic rate are closed related and high leaf N and chlorophyll increase the photosynthetic rate. Therefore, application of N increases the leaf area and photosynthetic rate and thus increases dry matter production. Prolonged use of chemical fertilizers degrades the soil health and affects crop yield. Application of higher doses of nitrogen especially for seed crop of French bean is imperative for realizing its potential yield (Sardana *et al*., 2000). There is also report that French bean is in sufficient in trapping atmospheric nitrogen due to lack of nodulation in north Indian plains (Kushwaha, 1994). Therefore, it requires large quantity of nitrogenous fertilizer. Increasing cost of inorganic fertilizers and reduction in soil health with chemical Fertilizers there is a need of present are to use of eco-friendly inputs like vermicompost, bio fertilizer viz., Phosphorus solubilizing bacteria, Rhizobium along with inorganic fertilizers.

Biofertilizer required to restore the fertility of the soil. Prolonged use of chemical fertilizers degrades the soil and affects crop yield. Biofertilizers, on the other hand enhance the water holding capacity of the soil and add essential nutrients such as nitrogen, vitamins, and proteins to the soil. Microbes in biofertilizers provide atmospheric nitrogen directly to plants. They aid in solubilisation and mineralisation of other plant nutrients like phosphates. Better synthesis and availability of hormones, vitamins, auxins, and other growth - promoting substances improves plant growth. The interaction of biofertilizer along chemical fertilizer the requirement of inorganic fertilizer will reduced will be better for ecosystem, as the use of fertilizer is one most important factor to increase all growth parameters and yield of crop (Kumar *et al.* 2014).

2. MATERIALS AND METHODS

This experiment was laid out during the *Rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is

situated at 25^0 39" 42" N latitude, 81^0 67" 56" E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in Randomized Block Design Which consisting of ten treatments with T_1 – Nitrogen 75kg + *Rhizobium*, T_2 – Nitrogen 75 kg + PSB, T_3 – Nitrogen 75 kg + *Rhizobium*+ PSB, T_4 - Nitrogen 100 kg + *Rhizobium*, T_5 Nitrogen 100 kg + PSB, T_6 - Nitrogen 100 kg + *Rhizobium*+ PSB, T_7 - Nitrogen 125 kg + *Rhizobium*, T_8 - Nitrogen 125 kg + PSB, T_9 - Nitrogen 125 kg + *Rhizobium*+ PSB, T_{10} - Control (NPK 100-80-60 kg/ha).The soil in the experimental area was sandy loam with pH (8.0), Organic Carbon (0.42%), Available N (180.58 kg/ha), Available P (15.54 kg/ha), and Available K (198.67 kg/ha). Seeds are sown at a spacing of 45×15 cm^2 to a seed rate of 80 kg/ha. The recommended dose of phosphorus (80 kg/ha), potassium (60 kg/ha) and Biofertilizer and Nitrogen were applied as per the treatments. Data recorded on different aspects of crop, *viz.,* growth, yield attributes were subjected to statistically analysis by analysis of variance method. (**Gomez and Gomez, 1976)** and economic data analysis mathematical method.

RESULT AND DISCUSSION:

Growth parameters

In the present investigation growth parameters were found to be maximum for plant height(cm), plant dry weight(g) and crop growth rate (g/m^2/day) in treatment 6 [Nitrogen 100 kg + *Rhizobium* + PSB] which was followed by treatment 9 [Nitrogen 125 kg + *Rhizobium* + PSB]. Least growth parameters were observed in treatment 1 [Nitrogen 75kg + *Rhizobium*]. The increase was found to be rapid between 40-80 as compared to 20-40. However maximum plant height(46.19 cm), plant dry weight (26.20 g) and crop growth rate (8.22 g/m^2/day) was recorded at 80 DAS in treatment 6 [Nitrogen 100 kg + *Rhizobium* + PSB] and least was recorded in treatment 1[Nitrogen 75kg + *Rhizobium*] of 37.14 cm plant height, 21 g dry weight and 6.13 g/m^2/day crop growth rate. The findings showed that the trend of increase in plant growth parameters were observed up to treatment 6 beyond that negative effect observed with increased nutrition. The plant growth parameters declined significantly at 125 kg/ha than 100 kg N/ha due to incomplete assimilation of nitrogen. When a nutrient is present in the soil in excess of plant requirement, the nutrient is absorbed in higher amounts which causes imbalance of nutrients or disorder in physiological processes (Reddy & Reddi, 2005). So, it might had affected on the conversion of NH3 into glutamic acid in plants resulting in the retardation of crop growth character like plant height at maximum level (125

kg/ha) of nitrogen. Similar effect was recorded in total dry matter production per plant (Table 1) at 80 DAS resulting in lower values of yield attributes (table 2). Moreover, according to Moniruzzaman *et al.* (2008), amount of nitrogen beyond optimum level brings about nutrient imbalance and suppresses growth of the plant. Growth inhibition has been attributed to various factors such as toxic effects of free ammonia and carbohydrate limitation (Cramer & Lewis, 1993) due to excessive consumption of soluble sugars for NH4+ assimilation (detoxification) (Walch-Liu *et al*., 2000). Ammonium induced inhibition of shoot growth has been reported for *Phaseolus vulgaris* L. (Chaillou *et al.* 1986). It is due to uncoupling of photophosphorylation, lack of carbohydrate and impairment of water status (Walch-Liu et al., 2000). Increase in plant growth parameters as compared to other lower nutrient levels might be due to the increase in nitrogen availability which might have promoted photosynthesis resulting in more assimilation of food material in plant. Similar results were obtained by Rajput *et al.* (2006) and Ramana *et al*. (2011).

The enteractiion effect of biofertilizers along with inorganic nitrogen was significant for growth parameters. Significant increase in plant height and plant dry weight with *Rhizobium* and PSB as compared to control might be due to increase in uptake of N and P by the plants, which might be due to more N-fixation and P-solubilisation through micro-organisms. Results were similar to (Ramana *et.al*.,2010) in French bean and (Singh *et al*.,2018) in chickpea.

Yield attributes and Yield

As depicted in table 2 the statistically analysed data pertaining to pods/plant, seeds/pod, seed yield, stover yield indicated that significant differences observed among the treatments. Treatment 6 [Nitrogen 100 kg + *Rhizobium* + PSB] recorded maximum pods/plant, seeds/pod, seed yield, stover yield (19.70, 5.08, 22.47 and 50.08) and least was observed in treatment 1 [Nitrogen 75kg + *Rhizobium*].

significantly higher pods per plant was found at Treatment 6 [Nitrogen 100 kg + *Rhizobium* + PSB] (19.73.) and all the remaining treatments were significantly less. Increased pods/plant might be due to increased assimilation of nitrogen and phosphorus which resulted from positive interaction between fertilizer and biofertilizers at 100 kg N/ha. Beyond this level negative effect observed. Verma and Saxena (1995) also reported that pods per plant of French bean increased significantly with the increase in

nitrogen level up to 120 kg/ha. Similar findings of the pods per plant of French bean was significantly higher at the nitrogen level of 120 kg/ha as compared to 80, 40 and 0 kg/ha in 1993 (Wani *et al*., 1998).

The seeds per pod was found to increase with the level of nitrogen from 0 to 100 kg/ha and then declined at 125 kg/ha (Table 2). The maximum number of grains per pod (5.08)

was obtained with 100 kg N/ha at treatment 6 [Nitrogen 100 kg + *Rhizobium* + PSB] and minimum (3.87) in treatment 1[Nitrogen 75kg + *Rhizobium*]. This is in conformity with the results obtained by Singh and Verma (2002) that grains per pod increased significantly with increasing level of nitrogen up to 120 kg/ha and beyond that negative impact observed. These findings are in agreement with Saxena and Verma (1995) that the increase in the nitrogen level from 0 to 120 kg/ha increased grains per pod significantly in French bean in 1989/90 and 1990/91. As seed is treated with biofertilizers better result was observed with recommended nitrogen level.

Increased seed yield and stover yield observed in treatment 6 [Nitrogen 100 kg + *Rhizobium* + PSB] (22.47 q/ha and 50.08 q/ha) and least in treatment 1[Nitrogen 75kg + *Rhizobium*] (16.00 q/ha and 43.55 q/ha). Increased yield by the biofertilizer interaction with fertilizer could be due to the greater availability of nutrients in the soil and better nodulation under the influence of inoculation resulting in better growth and development which might be attributed to better mobilization of important nutrients and increased allocation of photosynthates towards the economic parts and also hormonal balance on the plant system. This findings corroborate with the findings of Menaria *et al*. (2004) in soybean, Naagar *et al*. (2004) in cluster bean, Rajput *et al.* (2004) in Garden pea and Jain *et al. (*1999) in chick pea. Increase in yield by dual inoculation of *rhizobium* and PSB might be due to increased number of leaves and leaf area which determines the photosynthetic efficiency of plants, dry matter production and ultimately the yield.

CONCLUSION:

Based on the above findings it can be concluded that French bean with the application of *Rhizobium* and PSB along with the application of Nitrogen 100 kg/ha (Treatment 1) recorded highest plant height, dry weight, no. of pods/plant, no. of seeds/pod, seed yield and stover yield.

Table: 1 Influence of Nitrogen levels and Biofertilizers on growth of French bean.

S.No.	Treatment combinations	At 80 DAS		
		Plant height (cm)	**Dry weight (g/plant)**	**Crop growth rate(g/m^2/day))**
1.	Nitrogen 75kg + *Rhizobium*	37.14	21.00	6.13
2.	Nitrogen 75 kg + PSB	39.54	22.05	6.44
3.	Nitrogen 75 kg + *Rhizobium* + PSB	44.63	25.74	7.21
4.	Nitrogen 100 kg + *Rhizobium*	40.73	23.10	7.45
5.	Nitrogen 100 kg + PSB	41.43	23.50	7.45
6.	Nitrogen 100 kg + *Rhizobium* + PSB	46.19	26.20	8.22
7.	Nitrogen 125 kg + *Rhizobium*	42.38	23.77	7.34
8.	Nitrogen 125 kg + PSB	44.07	24.83	7.14
9.	Nitrogen 125 kg + *Rhizobium* + PSB	45.29	25.96	8.11
10.	Control (NPK 100-80-60 kg/ha)	40.20	22.79	7.59
	F-test	S	S	S
	SEm(±)	0.76	0.60	0.57
	CD (p=0.05)	2.24	1.77	1.68

Table: 2 Influence of Nitrogen levels and Biofertilizers on yield attributes and yield of French bean.

S.No.	Treatment combination	Number of pods /Plants	Number of seeds/pod	Seed Yield (q/ha)	Stover Yield (q/ha)
1.	Nitrogen 75kg + *Rhizobium*	14.00	3.87	16.00	43.55
2.	Nitrogen 75 kg + PSB	14.80	4.03	16.33	44.90
3.	Nitrogen 75 kg + *Rhizobium* + PSB	18.27	4.65	20.61	47.65
4.	Nitrogen 100 kg + *Rhizobium*	15.80	4.37	18.36	46.19
5.	Nitrogen 100 kg + PSB	16.00	4.44	18.76	46.00
6.	Nitrogen 100 kg + *Rhizobium* + PSB	19.70	5.08	22.47	50.08
7.	Nitrogen 125 kg + *Rhizobium*	16.67	4.51	19.79	46.03
8.	Nitrogen 125 kg + PSB	17.13	4.59	19.63	46.05
9.	Nitrogen 125 kg + *Rhizobium* + PSB	18.70	4.81	21.16	48.29
10.	Control (NPK 100-80-60 kg/ha)	15.33	4.37	17.53	45.86
	F-test	S	S	S	S
	SEm(±)	0.82	0.14	0.54	0.75
	CD (p=0.05)	2.45	0.40	1.62	2.40

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