

Effect of chemical and biofertilizer application on morphological and biochemical parameters of *Vigna radiata*

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Abstract

Agricultural practices are one of the most significant driving factors to support the economic development of the nation. As fertilizers account for a small portion of the overall cost of output in many developing countries, farmers frequently add fertilizers above the required rate to ensure high crop yield. By supplying plants with nutrients they serve as catalysts for their optimal growth and production but gradually, chemical fertilizers begin to show their ill impacts on the environment. With raising perception of the ill impacts of indiscriminate chemical use, the tendency of farmers toward environmentally sustainable technology is rising. Biofertilizer, on the other hand, refer to articles containing live or latent microbes which helps boost fertility of soil by either solubilizing phosphorus, fixing atmospheric nitrogen, decomposing organic waste or stimulating growth of plant through the synthesis of growth-promoting substances. A poly pot experiment was carried out to study the effect of chemical and biofertilizer application on morphological and biochemical parameters of *Vigna radiata* and found that the combined application of both fertilizers significantly enhanced the value of experimental parameters as compared to the control as well as their single treatments. Therefore, it could be reduce the dependency on chemical fertilizers to improve the crop growth and productivity for sustainable agricultural practices.

Keywords: Biofertilizer, chemical fertilizer, *Vigna radiata*

Introduction

Agricultural practices are one of the most important sources for livelihood in India. In order to feed the growing population and consummate the demand of the nation, it has to increase its productivity. Due to this, the present time agricultural system is totally depend on the chemical fertilizers. The use of nitrogen, phosphorus and potassium based chemical fertilizers enhance the growth and productivity of crops in agricultural fields to some extent but, gradually chemical fertilizers begin to show their ill impacts such as polluting water basins and leaching out, killing microorganisms and helpful insects, rendering the crop more perceptible to disease invasions and decreasing soil fertility^[1]. Today, biofertilizers are important in agricultural practices because of their role in maintenance of soil health, environmental pollution reduction and also minimize the use of chemicals^[2]. Biofertilizer includes microorganisms that encourage the adequate nutrient supply to the host plants and make sure their proper growth, production, and physiological control. These are important components of sustainable farming which play a crucial role in maintaining long- lasting soil fertility and crop production sustainability^[2, 3]. BNF (Biological nitrogen fixation) is the most sustainable and lowest cost source of nitrogen⁴. Their eco-friendly, simple to spread, non-toxic and cost-effective existence, biofertilizers have emerged today as a highly efficient alternative to chemical fertilizers. An experimental study was carried out to examine the effect of chemical and biofertilizer application on morphological and biochemical parameters of *Vigna* crop. The experimental *Vigna* species was green gram (*Vigna radiata* L. Wilczek; var. sweta) also locally named as mung bean. It is an annual herbaceous self-fertilized crop. Plants are rising to a height of 30 to 100 cm containing trifoliolate leaves,

along with yellow colored flowers formed in axillary racemes. It is an important source of quickly digestible protein to the vegetarian population of the nation.

Biofertilizers improve the potency of chemical fertilizers utilizing a carrier material on which microbes are placed^[5]. Vikram *et al*^[6] proposed the potential usage of effective PSB strains as a biofertilizer to improve crop production. There are many studies that showed the combined application of chemical fertilizers and biofertilizers significantly influenced the growth and yield of many crops and improve the crop productivity thus, reduced the dependency on chemical fertilizers to increase their yield. Biofertilizers with reduced amount of chemical fertilizers recommended for better yield of chickpea^[7].

The present study was undertaken to identify specific level of fertilizers with reduced or minimized dose of chemical fertilizer to obtain maximum value for morphological and biochemical parameters of *Vigna radiata*. The main purpose of the present study was looking for the best fertilizer level either single or in combination of chemical and biofertilizer, to obtain enhanced plant growth in addition to keep sustainable and safe environment due to the minimize the use of chemical fertilizer.

Materials and Methods

To study the effect of chemical (DAP) and biofertilizer (PSB) application on morphological and biochemical parameters of *Vigna radiata*, a poly pot experiment, based on randomized complete block design (RCBD) with three replicates of 10 plants per treatment was carried out during kharif season (2017) at department of Botany, D. V. College, Orai (Jalaun) in Bundelkhand region of Uttar Pradesh, India. Bundelkhand region lies in south-west corner of Uttar Pradesh (India) and is predominantly

drought prone area which is extended 24°11' and 26°27' N latitude and 78°17' and 81°34' E longitudes with an average altitude ranging 250 to 300 m above MSL (mean sea level)⁸.

Collection of Materials

For the present experimental study purpose, black soil, locally called as 'kabar' was collected from neighboring localities of Orai. Experimental crop seed (certified) and PSB (Phosphate Solubilizing Bacteria) biofertilizer culture were obtained from kendriya krashi beej bhandar, Orai whereas, chemical fertilizer as DAP (Diammonium Phosphate) obtained from IFFCO, Orai.

Soil Treatments

There were total sixteen soil treatments (T₁ to T₁₅) prepared containing single as well as in combination of different doses of chemical fertilizer i.e. DAP (0.25 g, 0.50 g and 1.00 g of DAP per kg of soil) and biofertilizer i.e. PSB (as 2.50 g, 5.00 g and 10.00 g of PSB per kg of soil) with a control treatment (T₀) i.e. without fertilizer application (Table 1). Fixed doses of experimental fertilizers were mixed well with calculated amount of soil to prepare different fertilizer levels.

Sowing of Seeds

Plants were raised in black colored 12 inches poly flower pots with a bottom and few on the upper edge drainage holes. Before sowing, *Vigna* seeds were surface sterilized with 0.1% HgCl₂ for two minutes and thoroughly washed with distilled water. Then, the seeds were sown in poly pots with treated soil according to the Table 1. As many as 10 seeds were sown in each pot. Thinning of plants was done when required.

Table 1: Different levels of chemical fertilizer (DAP) and biofertilizer (PSB)

S. No.	Treatments	Doses (in per kg of soil)
1	T ₀	Control (Without fertilizer)
2	T ₁	0.25g of DAP
3	T ₂	0.50g of DAP
4	T ₃	1.00g of DAP
5	T ₄	2.50g of PSB
6	T ₅	5.00g of PSB
7	T ₆	10.00g of PSB
8	T ₇	0.25g of DAP×2.50g of PSB
9	T ₈	0.25g of DAP×5.00g of PSB
10	T ₉	0.25g of DAP×10.00g of PSB
11	T ₁₀	0.50g of DAP×2.50g of PSB
12	T ₁₁	0.50g of DAP×5.00g of PSB
13	T ₁₂	0.50g of DAP×10.00g of PSB
14	T ₁₃	1.00g of DAP×2.50g of PSB
15	T ₁₄	1.00g of DAP×5.00g of PSB
16	T ₁₅	1.00g of DAP×10.00g of PSB

Observations and Data Analysis

Experimental parameters of *Vigna* crop was observed, analyzed and recorded at requisite time intervals from seed germination to harvesting. Length of root and shoot were measured by using a centimeter scale and the mean value recorded by randomly selected three normal seedlings. To measure fresh weight of stem and leaves, plant samples were cut with sharp blade and properly water washed. After that blotted with blotting paper and weighed in gram (g). Leaf area index (LAI) per plant was calculated with the help of formula given by Watson^[9]. Chlorophyll content of fresh leaves of plant sample was determined by Petering method

^[10]. Phosphorus content of leaves was determined by the molybdenum reduced phosphomolybdic acid blue color method in H₂SO₄ system. The blue color was determined in Elico-CL-20A photo-electric colorimeter using red filter. Potassium content of leaves was measured turbidimetrically. The turbidity produced at 20 °C under standardized conditions was estimated in Elico-CL-20A photo-electric colorimeter using red filter and the nitrogen content of leaves was determined by semi-micro-kjeldahl method. All these parameters were recorded at requisite time intervals (30 and 60 DAS) of crop growing period. Average values of the experimental parameters were shown in Table 2A and 2B. The data for the various experimental parameters in the present study were ANOVA tested and the significance of differences between control and each treatment was determined by using the value of least significant difference (L.S.D.) at P=0.05 and P=0.01.

Results and Discussion

Overall maximum value of the experimental parameters recorded with combined application of chemical (DAP) and biofertilizer (PSB). The interaction levels of DAP and PSB significantly influenced the morphological and biochemical parameters tested in *Vigna radiata* plants. The application of interaction 1.00 g DAP×10.00 g PSB per kg soil (T₁₅) level showed overall maximum root length (6.30 cm and 15.20 cm at 30 and 60 DAS respectively), shoot length (15.00 cm and 34.70 cm at 30 and 60 DAS respectively), fresh weight of stem (2.98 g and 3.89 g at 30 and 60 DAS respectively), fresh weight of leaves (1.36 g and 2.18 g at 30 and 60 DAS respectively), leaf area index (0.45 and 2.85 cm² at 30 and 60 DAS respectively), phosphorus content (0.34 and 0.48 percent at 30 and 60 DAS respectively), potassium content (0.67 and 1.09 percent at 30 and 60 DAS respectively) and nitrogen content (2.21 and 3.24 percent at 30 and 60 DAS respectively) in leaves of *V. radiata* plants as compared to the control (Table 2A and 2B). Whereas, overall maximum value for chlorophyll content (2.52 mg and 3.98 mg at 30 and 60 DAS respectively) recorded at interaction 0.50 g DAP×10.00 g PSB per kg soil (T₁₂) level over the control in *V. radiata* plants (Table 2A and 2B). Bacteria enhanced the root growth in plants which in turn improved nutrient uptake and water absorption from soil and favoured the improvement in crop yield^[11]; similar findings observed with rice crop^[12]. *Echinochloa frumentacea* found improved values of morphological and yield parameters in combined application of biofertilizer and synthetic fertilizer than using either method alone^[13]. Maximum value for chlorophyll, carbohydrate and protein content in *stevia rebaudiana* observed with the combination of biofertilizer and chemical fertilizer as compared to control^[14]. Application of PSB with phosphoric fertilizer had a significant effect on growth and yield of *Zea mays*^[15]. Combined application of biofertilizer and chemical fertilizer showed increased fresh and dry weights of leaves in *Spathiphyllum illusion*^[16]. Higher values for growth in both root and shoot length and biomass were recorded with the application of PSB alone or in group of compatible strains with or without chemical fertilizer in *Oryza sativa* and *Vigna unguiculata* than contro^[17]. Similar results were recorded in *Chamaedorea elegans* with the biofertilizer application^[18]. Phosphorus solubilizing bacteria supported the phosphorus solubilization process in the soil to increase the phosphorus availability to plants^[19].

Table 2: Effect of chemical (DAP) and biofertilizer (PSB) application on morphological parameters of *Vigna radiata*

Fertilizer	Treatment Level (g per kg soil)	Root length (cm)		Shoot length (cm)		Fresh weight (g) of stem		Fresh weight (g) of leaves		Leaf area index (cm ²)	
		30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Control	T ₀	4.46	9.23	8.50	24.06	1.42	2.37	1.05	2.02	0.25	1.86
DAP	T ₁	4.80	12.13	9.06	30.33	1.93	2.72	1.12	2.08	0.28	2.27
	T ₂	4.73	10.13	8.83	28.90	1.81	2.57	1.12	2.05	0.26	2.27
	T ₃	4.60	9.30	8.73	27.73	1.54	2.41	1.10	2.03	0.26	2.25
PSB	T ₄	4.66	9.86	9.00	27.13	1.81	2.76	1.11	2.07	0.28	2.10
	T ₅	4.83	10.50	9.90	28.70	1.92	2.94	1.14	2.08	0.30	2.47
	T ₆	5.06	11.93	10.20	29.90	2.12	3.10	1.22	2.11	0.31	2.64
DAP×PSB	T ₇	4.93	12.20	9.40	31.43	2.19	2.92	1.16	2.12	0.31	2.36
	T ₈	5.10	12.53	9.96	32.13	2.39	3.12	1.20	2.12	0.33	2.51
	T ₉	5.23	12.96	10.93	32.93	2.71	3.23	1.27	2.14	0.34	2.71
	T ₁₀	5.40	12.33	10.10	31.90	2.33	3.15	1.22	2.14	0.33	2.41
	T ₁₁	5.56	13.03	10.43	32.93	2.46	3.37	1.28	2.15	0.37	2.69
	T ₁₂	5.83	14.83	11.00	33.56	2.79	3.78	1.31	2.16	0.39	2.78
	T ₁₃	5.63	12.60	12.10	33.70	2.62	3.45	1.28	2.16	0.35	2.45
	T ₁₄	6.13	13.36	13.50	34.20	2.73	3.77	1.34	2.17	0.43	2.74
	T ₁₅	6.30	15.20	15.00	34.70	2.98	3.89	1.36	2.18	0.45	2.85
L.S.D.	P=0.05DAP	0.36	0.48	0.41	0.57	0.25	0.23	0.03	0.02	0.02	0.09
	P=0.01DAP	0.45	0.59	0.51	0.71	0.32	0.28	0.04	0.02	0.02	0.11
	P=0.05PSB	0.36	0.48	0.41	0.57	0.25	0.23	0.03	0.02	0.02	0.09
	P=0.01PSB	0.45	0.59	0.51	0.71	0.32	0.28	0.04	0.02	0.02	0.11
	P=0.05 DAP×PSB	0.99	1.31	1.13	1.57	0.70	0.62	0.09	0.05	0.05	0.23
P=0.01 DAP×PSB	1.16	1.53	1.32	1.84	0.82	0.72	0.11	0.06	0.06	0.27	

Table 2: Effect of chemical (DAP) and biofertilizer (PSB) application on biochemical parameters of leaves of *Vigna radiata*

Fertilizer	Treatment Level	Chlorophyll (mg/100g Fresh weight of leaf)		Phosphorus content (%)		Potassium content (%)		Nitrogen content (%)	
		30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Control	T ₀	1.22	2.75	0.18	0.33	0.41	0.81	1.79	2.91
DAP	T ₁	1.39	3.18	0.22	0.37	0.47	0.84	1.97	3.01
	T ₂	1.26	3.11	0.21	0.35	0.46	0.83	1.96	3.01
	T ₃	1.37	3.16	0.19	0.34	0.42	0.81	1.95	2.99
PSB	T ₄	1.30	3.18	0.21	0.35	0.44	0.82	1.81	3.01
	T ₅	1.54	3.14	0.21	0.37	0.45	0.85	1.83	3.06
	T ₆	1.81	3.21	0.23	0.42	0.46	0.87	1.88	3.11
DAP×PSB	T ₇	1.69	3.13	0.24	0.38	0.47	0.86	2.05	3.04
	T ₈	1.74	3.39	0.26	0.41	0.48	0.90	2.08	3.11
	T ₉	1.93	3.45	0.28	0.43	0.52	0.92	2.11	3.15
	T ₁₀	2.24	3.69	0.28	0.42	0.52	0.88	2.08	3.11
	T ₁₁	2.43	3.77	0.28	0.44	0.55	0.93	2.11	3.16
	T ₁₂	2.52	3.98	0.31	0.46	0.59	1.02	2.17	3.21
	T ₁₃	1.78	3.43	0.31	0.45	0.57	0.93	2.11	3.13
	T ₁₄	1.92	3.52	0.31	0.47	0.61	1.01	2.13	3.19
L.S.D.	T ₁₅	2.11	3.57	0.34	0.48	0.67	1.09	2.21	3.24
	P=0.05 DAP	0.08	0.07	0.02	0.02	0.03	0.06	0.04	0.04
	P=0.01 DAP	0.10	0.09	0.02	0.02	0.03	0.07	0.05	0.05
	P=0.05 PSB	0.08	0.07	0.02	0.02	0.03	0.06	0.04	0.04
	P=0.01 PSB	0.10	0.09	0.02	0.02	0.03	0.07	0.05	0.05
	P=0.05 DAP×PSB	0.23	0.19	0.05	0.05	0.08	0.16	0.11	0.12
P=0.01 DAP×PSB	0.27	0.23	0.06	0.06	0.09	0.19	0.13	0.14	

(DAS= Days after sowing; L.S.D. = Least significant difference)

In the present study, PSB and DAP both positively influenced the growth of *Vigna* crop plants over the control. PSB in addition to phosphate solubilization, are also capable of producing growth hormones such as auxins, cytokinins and gibberellins, vitamins, antibiotics, siderophores etc. and due to this property they enhance plant growth and suppress the soil born pathogens and also improve physico-chemical properties of the soil and sustain soil fertility [20]. Reduction in the use of chemical fertilizers up to 50 percent noticed

through the biofertilizer application in of fennel plants without any reduction in growth of plants and yield [21, 22, 23].

Conclusion

It concluded from the experimental study that the interaction 1.00 g DAP×10.00 g PSB per kg soil level (T₁₅) was significantly influenced the root length, shoot length, fresh weight of stem as well as leaves, leaf area index, phosphorus, potassium and also nitrogen content of leaves

in *V. radiata* plants whereas, interaction 0.50 g DAP×10.00 g PSB level (T₁₂) was significantly influenced the chlorophyll content of the leaves of *V. radiata* plants. Therefore, soil treatment with combined application of chemical fertilizer (DAP) and biofertilizer (PSB) was found significant on morphological and biochemical parameters of *Vigna radiata* as compared to the control. The combination of chemical fertilizer and biofertilizer can reduce the dependency on chemical fertilizers alone to improved crop growth and yield for sustainable agricultural system. It is suggested from the study that biofertilizer application could be applied as enhancer for agricultural crops to minimize the quantity of chemical fertilizers in agricultural system to save and protect the environment.

The present investigation is the primary stage of study to analyze the response of different levels of chemical (DAP) and biofertilizer (PSB) on morphological and biochemical parameters of *V. radiata* crop. In Future, studies may be conducted to examine the same on different crop growth and yield with the application of different chemical and biofertilizer at different levels to enhance the crop production.

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