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ORIGINAL ARTICLE

Impact of different levels of fertilizers on growth and yield components of Mungbean (*Vigna radiata*)

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ABSTRACT
In present day agricultural system, chemical fertilizers are used widely to increase crop yields. 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 perceptive to disease invasions and decreasing soil fertility. The purpose of the present experimental study was to reduce or minimize the dependency on chemical fertilizers to improve crop yield and replace it with biofertilizers as they are ecofriendly and comparatively less cost inputs in sustainable agricultural system. A poly pot experiment was carried out to study the effect of different levels and their combinations of chemical fertilizer (DAP) and biofertilizer (PSB) on growth and yield components of Vigna radiata crop. The maximum values of experimental parameters observed with combined/mixed application of both fertilizers. Therefore, it concluded that the effect of combined/mixed application of chemical fertilizer (DAP) and biofertilizer (PSB) was found significant on growth and yield components of V. radiata as compared to control. It could be reduce the dependency on chemical fertilizers to improve the growth and yield of crop for sustainable agricultural practices. Thus, it is suggested from the study that biofertilizer application could be applied as enhancer for agricultural crops to replace and/or minimize the quantity of chemical fertilizers in agricultural system to save and protect our environment.
Key words: Fertilizer levels, DAP, PSB, *Vigna radiata*, Growth parameters.

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INTRODUCTION

An agricultural practice is generally soil dependent and also one of the most significant driving factors to India's economic development. The upper part of soil favours growth of plants. It is formed by the interaction among biotic and abiotic components like living organisms, rocks, air, water, and other materials. The soil fertility is its ability to support high yield of good quality crops [1]. In general, most plants grow by absorbing nutrients from the soil. In mineral nutrients, nitrogen, phosphorus and potassium are needed in large quantities and are most likely to be in less supply in agricultural soils.

In present time, fertilizer has become important to modern agriculture for the feeding of rising populations. They act as catalysts in providing nutrients to plants for their optimum growth and yield. Farmers inoculate the fields with fertilizers to secure a preferable yield. Excessive usage of chemical fertilizer not only accelerates soil acidification but also has the ability to contaminate groundwater and the environment. Hence reliance on chemical fertilizers for potential agricultural development will lead in more degradation of soil fertility and water pollution possibilities. Besides this, biofertilizer refers to the preparation, containing live or latent microbes which help in improving the fertility of soil either by atmospheric nitrogen fixation, phosphorus solubilization, decomposing organic wastes or synthesis of growth-promoting substances to stimulate the plant growth. Application of the beneficial microorganisms in agricultural practices started around 60 years ago and it is now revealed that such beneficial microbes may even improve plant resistance to adverse environmental pressures such as water and nutrient shortage and heavy metal pollution [2]. Recently, biofertilizers are gaining quickness due to the

increasing insistence on maintenance of soil health, reducing the environmental pollution and cut down on the use of chemicals in agriculture that will lead to sustainable agricultural production [3].
In the present study, the experimental crop is the member of leguminous family as green gram (*Vigna radiata* L. Wilczek; var. 'Sweta') also called as mung bean which is small herbaceous annual plant which is growing to a height of 30 to 100 cm, leaves are trifoliate with long petioles, produce yellow coloured flowers in axillary racemes, and self-fertilized crop with epigeal germination. Green gram plays a significant role in Indian diet and provides quickly digestible wide proportion of protein requirement of the vegetarian population of the nation. The potential of pulses to help address future global food scarcity, nutrition and environmental sustainability needs has been acknowledged through the UN declaration of the '*2016 International year of Pulses'* [4]. The present study was undertaken to identify specific level of fertilizers with reduced or minimized dose of chemical fertilizer for maximum growth and yield components of *Vigna radiata*.

MATERIAL AND METHODS

Experimental design and site: 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 to study the effect of different levels (single and their combinations) of chemical fertilizer (DAP) and biofertilizer (PSB) on growth and yield components of *Vigna radiata*.
Collection of materials: For the present experimental study purpose, black soil was collected from neighbouring localities of Orai. Experimental crop seeds (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 (T_0, T_1 to T_{15}) prepared containing different doses of chemical fertilizer (as 0.25g, 0.50g and 1.00g of DAP per kg of soil) and biofertilizer (as 2.50g, 5.00g and 10.00g of PSB per kg of soil) with a control (T_0) i. e. without fertilizer application (Table-1). Fixed doses of experimental fertilizers were mixed well with calculated amount of soil to prepare fertilizer levels.
Sowing of seeds: Plants were raised in black coloured 12 inch poly/plastic flower pots with a bottom and few on the upper edge drainage holes. Before sowing, *Vigna* crop seed surface were sterilized with 0.1% $HgCl_2$ 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 15 seeds were sown in each pot.
Observations and data analysis: After the seed germination, seedlings were thinned to a uniform number as 10 seeds in each pot. Experimental parameters of growth and yield were observed, analyzed and recorded at requisite time intervals from seed germination to harvesting. Seed germination percentage was recorded at 7th DAS (Days after sowing). Length of shoot and root were measured and recorded by randomly selected three normal seedlings. To measure fresh weight of shoot, plant samples were cut with sharp blade and properly water washed. After that blotted with blotting paper and weighed in gram (g). Chlorophyll content of fresh leaves of plant samples was determined by Petering method [5]. All these components were recorded at requisite time intervals (30 and 60 DAS) during crop growing period. The siliquae number per plant and seeds number per siliqua in each of the randomly selected plant were measured at 85th DAS after harvesting. Dry weight (g) of 100 seeds was also recorded after harvesting (85th DAS). Average values of different experimental parameters were shown in Table-2. The data on experimental parameters of growth and yield components of *Vigna radiata* were ANOVA calculated.

RESULTS AND DISCUSSION

Effect on growth components: The values of experimental growth components as seed germination percentage, shoot and root length, shoot fresh weight and chlorophyll content were found maximum with single fertilizer application of 0.25g/kg soil DAP level (T_1) and 10.00g/kg soil PSB level (T_6) (Table-2). Maximum seed germination (100%) recorded in application of 10.00g PSB/kg soil with 0.50g DAP/kg soil (T_{12}) and 1.00g DAP/kg soil (T_{15}) (Fig. 1). Application of 10.00g PSB/kg soil with 1.00g DAP/kg soil (T_{15}) favoured significant influence on all other experimental growth components except chlorophyll content of leaves. Maximum values for shoot length were 15.00 cm at 30 DAS and 34.70 cm at 60 DAS (Fig. 2) and root length were 6.30 cm at 30 DAS and 15.20 cm at 60 DAS (Fig. 3) observed with the application of 10.00g PSB/kg soil with 1.00g DAP/kg soil (T_{15}) (Table-2). Increased plant height and LAI (leaf area index) were observed in different crops inoculated with *Pseudomonas, Azospirillum* and *Azotobacter* strains [6 & 7]. Maximum fresh weight of shoot were 2.98g at 30 DAS and 3.89g at 60 DAS (Fig. 4) observed with the combined application of 10.00g PSB/kg soil and 1.00g DAP/kg soil (T_{15}) (Table-2).

Biofertilizers with fixative bacteria increased the absorption potential of plant and dry material in plant [8]. The values of chlorophyll content were 2.52 mg at 30 DAS and 3.98 mg at 60 DAS (Fig. 5) found maximum with the application of 10.00g PSB/kg soil with 0.50g DAP/kg soil (T_{12}) (Table-2). Significantly increased chlorophyll content in corn (*Zea mays* L.) leaves observed with the application of biofertilizer and Urea [9]. The chlorophyll content found increased due to the increased of nitrogen content in the plants attributed to the nutrients release in available forms in the soil through the microbial action [10 & 11]. Combined application of biofertilizer and chemical fertilizer showed increased chlorophyll content and fresh and dry weights of leaves in *Spathiphyllum illusion* [12]. Significantly enhanced seedlings growth and increased values for chlorophyll and nitrogen content in leaves were recorded in *Chamaedorea elegans* with the biofertilizer application [13]. Various growth parameters of cereals found significantly changed with the *Azospirillum* inoculation [14 & 15]. In addition to phosphate solubilization, PSB produced growth hormones, vitamins, antibiotics, siderophores etc. which enhanced the growth of plants [16].

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

S. No.	Treatments	Doses (in per kg of soil)
1	T0	Control (Without fertilizer)
2	T1	0.25g of DAP
3	T2	0.50g of DAP
4	T3	1.00g of DAP
5	T4	2.50g of PSB
6	T5	5.00g of PSB
7	T6	10.00g of PSB
8	T7	0.25g of DAP+2.50g of PSB
9	T8	0.25g of DAP+5.00g of PSB
10	T9	0.25g of DAP+10.00g of PSB
11	T10	0.50g of DAP+2.50g of PSB
12	T11	0.50g of DAP+5.00g of PSB
13	T12	0.50g of DAP+10.00g of PSB
14	T13	1.00g of DAP+2.50g of PSB
15	T14	1.00g of DAP+5.00g of PSB
16	T15	1.00g of DAP+10.00g of PSB

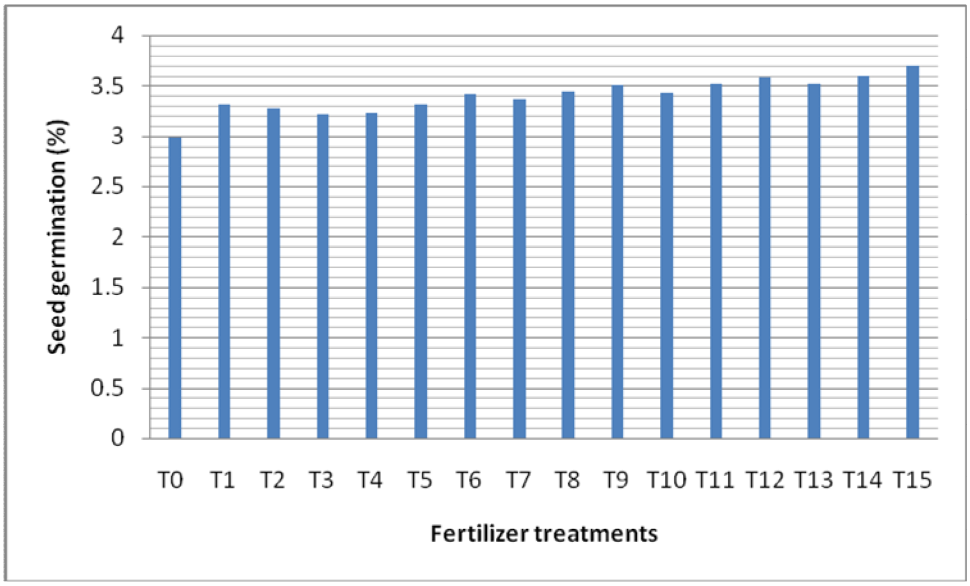

Fig. 1- Effect of different levels of DAP and PSB application on seed germination (%) of mung seeds at 7th DAS

Table-2: Effect of different levels of chemical fertilizer (DAP) and biofertilizer (PSB) on *Vigna radiata*

No. of Treatment	Treatment	Seed germination (%)	Shoot length (cm)		Root length (cm)		Fresh weight (g) of shoot		Chlorophyll (mg/100g Fresh weight of leaf)		Silique no. per plant	No. of seeds per siliqua	100 seeds dry weight (g)
		7th DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	85th DAS	85th DAS	85th DAS
1	T0	83.33	8.50	24.06	4.46	9.23	1.42	2.37	1.22	2.75	21.66	6.66	2.99
2	T1	86.66	9.06	30.33	4.80	12.13	1.93	2.72	1.39	3.18	25.00	7.66	3.31
3	T2	83.33	8.83	28.90	4.73	10.13	1.81	2.57	1.26	3.11	24.00	7.33	3.27
4	T3	83.33	8.73	27.73	4.60	9.30	1.54	2.41	1.37	3.16	22.66	7.00	3.21
5	T4	83.33	9.00	27.13	4.66	9.86	1.81	2.76	1.30	3.18	24.33	7.00	3.22
6	T5	86.66	9.73	28.70	4.83	10.50	1.92	2.94	1.54	3.27	26.00	7.66	3.31
7	T6	93.33	10.20	29.90	5.06	11.93	2.12	3.10	1.80	3.31	27.33	8.33	3.42
8	T7	90	9.40	31.43	4.93	12.20	2.19	2.92	1.69	3.29	26.66	8.33	3.36
9	T8	93.33	9.96	32.13	5.10	12.53	2.39	3.12	1.74	3.43	27.66	8.66	3.44
10	T9	96.66	10.93	32.93	5.23	12.96	2.71	3.23	1.93	3.69	28.33	9.00	3.51
11	T10	93.33	10.10	31.90	5.40	12.33	2.33	3.15	2.24	3.45	27.66	8.66	3.43
12	T11	96.66	10.43	32.93	5.56	13.03	2.46	3.37	2.43	3.57	28.00	9.00	3.52
13	T12	100	11.00	33.56	5.83	14.83	2.79	3.78	2.52	3.98	29.00	9.33	3.58
14	T13	93.33	12.10	33.70	5.63	12.60	2.62	3.45	1.78	3.39	28.33	9.00	3.52
15	T14	96.66	13.50	34.20	6.13	13.36	2.73	3.77	1.92	3.52	29.33	9.66	3.59
16	T15	100	15.00	34.70	6.30	15.20	2.98	3.89	2.11	3.77	30.33	10.00	3.69
L.S.D.	P=0.05 DAP	5.77	0.41	0.57	0.36	0.48	0.25	0.23	0.08	0.07	0.92	0.75	0.06
	P=0.01 DAP	7.18	0.51	0.71	0.45	0.59	0.32	0.28	0.10	0.09	1.14	0.93	0.07
	P=0.05 PSB	5.77	0.41	0.57	0.36	0.48	0.25	0.23	0.08	0.07	0.92	0.75	0.06
	P=0.01 PSB	7.18	0.51	0.71	0.45	0.59	0.32	0.28	0.10	0.09	1.14	0.93	0.07
	P=0.05 DAP×PSB	15.8	1.13	1.57	0.99	1.31	0.70	0.62	0.23	0.19	2.52	2.06	0.16
	P=0.01 DAP×PSB	18.52	1.32	1.84	1.16	1.53	0.82	0.72	0.27	0.23	2.95	2.41	0.19

(DAP= Diammonium Phosphate; PSB= Phosphate Solubilizing Bacteria; DAS= Days After Sowing; L.S.D.= Least Significant Difference)

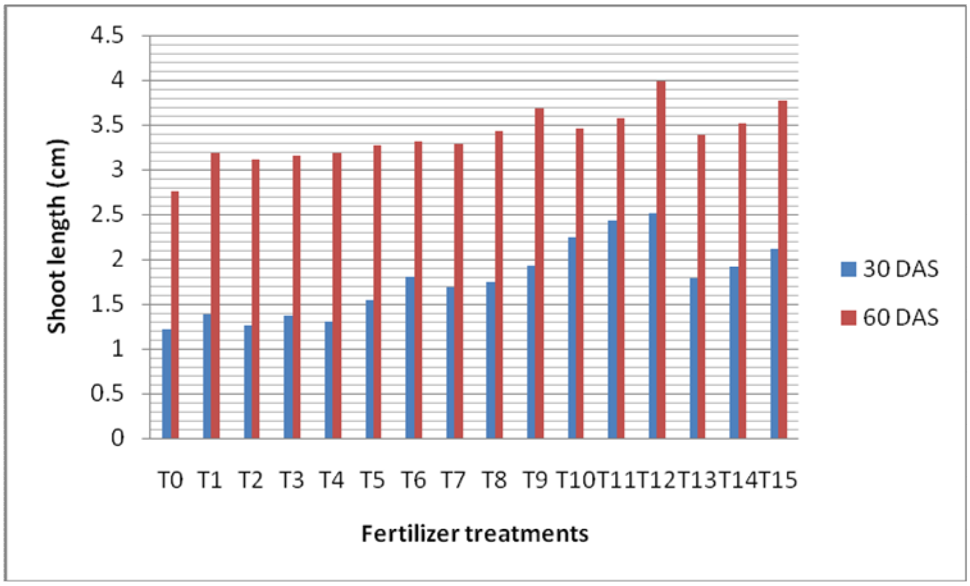

Fig. 2- Effect of different levels of DAP and PSB application on shoot length (cm) of mung plants

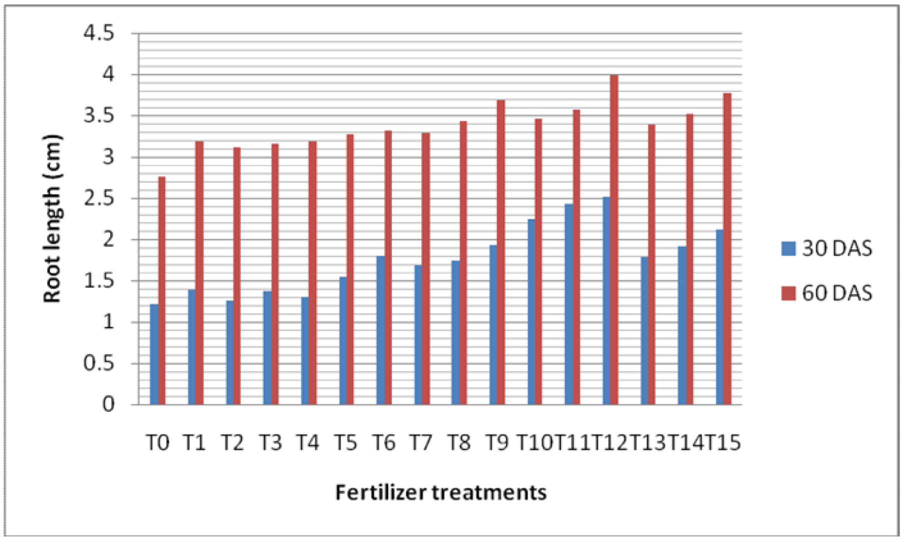

Fig. 3- Effect of different levels of DAP and PSB application on root length (cm) of mung plants

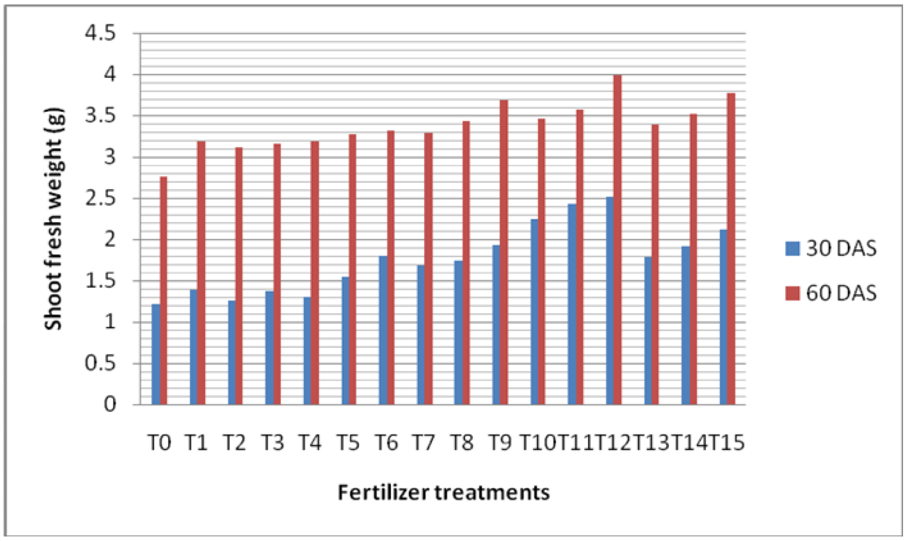

Fig. 4- Effect of different levels of DAP and PSB application on fresh weight (g) of shoot of mung plants

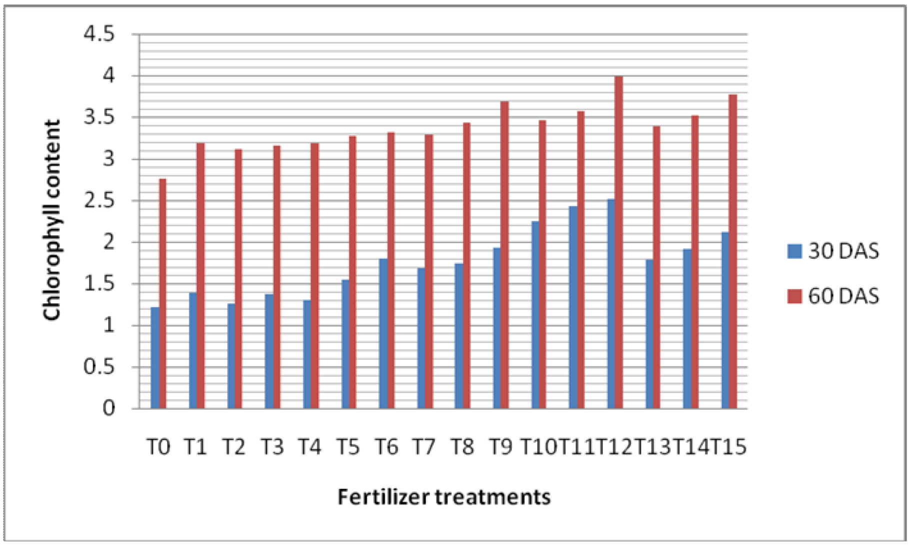

Fig. 5- Effect of different levels of DAP and PSB application on chlorophyll content (mg/100g Fresh weight of leaf) of mung plants

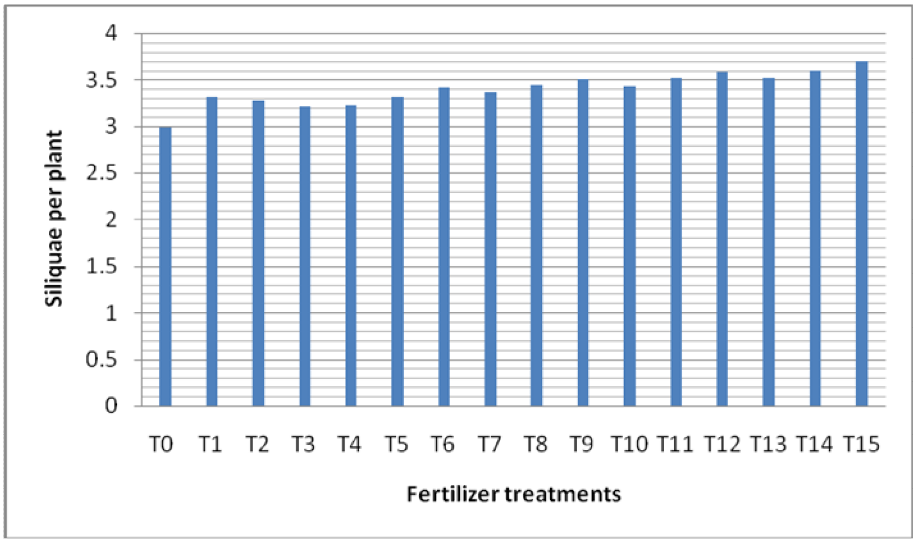

Fig. 6- Effect of different levels of DAP and PSB application on number of siliquae per mung plant at 85th DAS

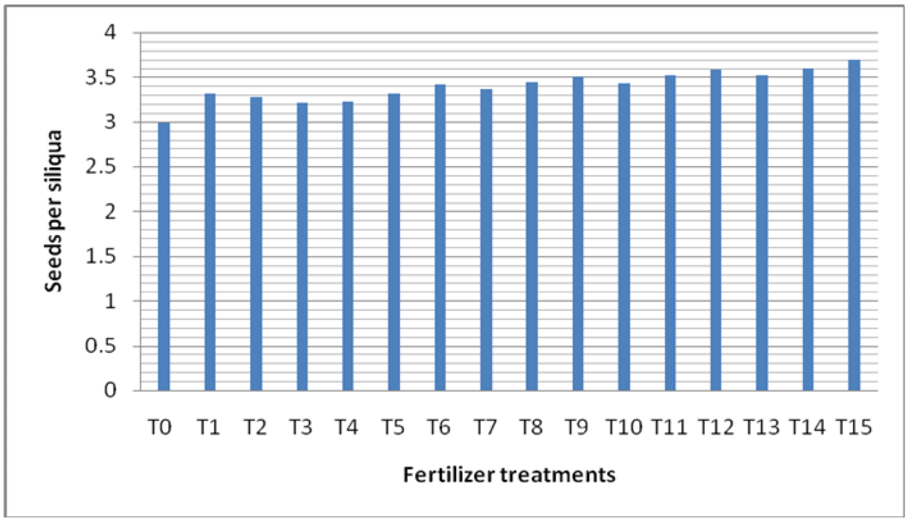

Fig. 7- Effect of different levels of DAP and PSB application on number of seeds per siliqua of Mung plants at 85th DAS

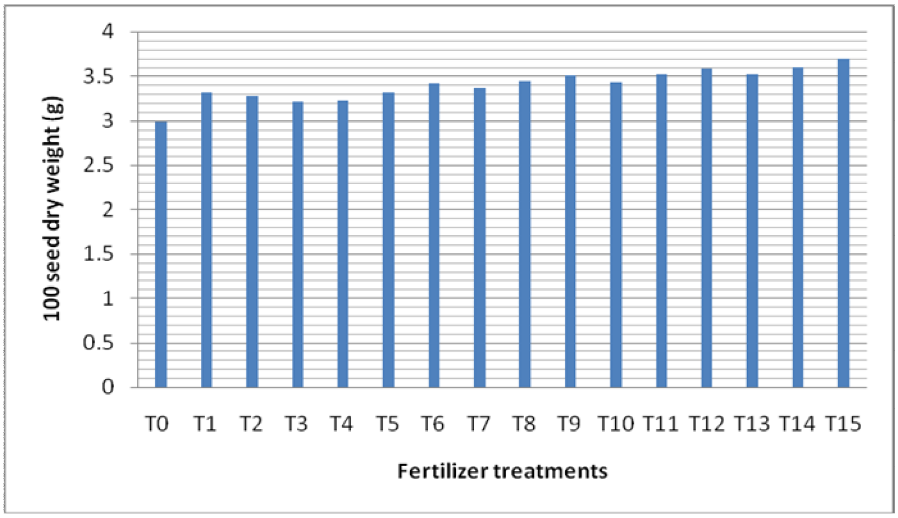

Fig. 8- Effect of different levels of DAP and PSB application on 100 seeds dry weight (g) of mung plants at 85th DAS

Effect on yield components: The values of experimental yield components as siliquae number in each plant, seed number in siliqua and 100 seed weight were found maximum with single fertilizer application of 0.25g/kg soil DAP level (T_1) and 10.00g/kg soil PSB level (T_6) (Table-2). Number of siliquae per plant was 30.33 at 85th DAS (Fig. 6), number of seeds per siliqua was 10.00 at 85th DAS (Fig. 7) and 100 seeds dry weight was 3.69g at 85th DAS (Fig. 8) found with 10.00g PSB/kg soil with 1.00g DAP/kg soil application (T_{15}) (Table-2). 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 [17]. Besides the biological nitrogen fixation, root colonizing bacteria produced the plant growth promoting substances which were responsible to the increased crop yield [18]. The yield of black gram showed a positive integrated effect of PSB inoculation with increased phosphorus level [19]. Phosphorus solubilizing bacteria supported the P solubilization process in the soil to increase the P availability to plants [20].

In the present study, PSB treatment favoured better performance than DAP and control. The similar effect of PSB observed in green gram [21] and in other crops [22, 23 & 24]. Reduction in the use of chemical fertilizers upto 50% noticed through the biofertilizer application in of fennel plants without any reduction in growth of plants and yield [25, 27 & 28]. Improved soil quality along with the growth and development in Maize plants were recorded with the application of PSB [26].

CONCLUSION

It conclude from the study that the effect of soil treatment containing a mixture of chemical fertilizer (DAP) and biofertilizer (PSB) was found significant on growth and yield components of *V. radiata* as compared to control treatment. Therefore, it suggested from the study that the combination of chemical fertilizer and biofertilizer can reduce the dependency on chemical fertilizers to crop growth and yield improvement for sustainable agricultural practices.

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