



Effect of phosphorus and biofertilizers on growth and yield of Mothbean (*Vigna aconitifolia* (Jacq.) Marechal) in Prayagraj conditions

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ARTICLE INFO	ABSTRACT
Received : 16 July 2021 Revised : 22 September 2021 Accepted : 24 October 2021 Published online: 31 January 2022	The present study was carried out during <i>Kharif</i> , 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj to determine the effect of phosphorus and biofertilizers on growth and yield of Mothbean (<i>Vigna aconitifolia</i> (Jacq.) Marechal). The experiment was set up in Randomized Block Design, consisting of 10 treatments replicated three times. The RMO 40 variety of Mothbean was sown in June, 2020. The results of the field experiment propound that application of 30 kg P/ha and seed inoculation by Rhizobia and Phosphate Solubilizing Bacteria significantly increased the growth parameters of mothbean viz., plant height (21.09 cm), branches per plant (6.53), nodules per plant (16.93), dry weight (5.481 g), crop growth rate (5.37 g/m ² /day). This treatment also showed its positive effect on number of pods (20.40), number of seeds (3.87), test weight (22.06 g) and seed yield (452.88 kg/ha) of the crop.
Key Words: Biofertilizers Growth parameters Phosphate Solubilising Bacteria (PSB) Phosphorus Rhizobia	

Introduction

Arid legumes form a very important source of staple food and nutrients, rich in protein for human beings. Arid legumes such as mothbean, lentil, horse gram, etc. are grown mostly in infertile and eroded soils, dry land areas with lack of irrigation facility and low in rainfall. They have spreading habit with good vegetative growth, provide effective cover to ground surface, prevent soil erosion and improves the fertility of the soil. Growing arid legumes with proper cultural practice and addition of fertilizers allows for the remedy of soil deficiencies as well as creation of proper soil physical conditions required for crop growth and productivity. Mothbean, also known as moth, mat bean, matki and dew bean is an essential component of dry land farming system in arid and semi-arid areas of India. It is one of the significant wellspring of protein, and one of the most drought tolerant crop among kharif pulses. Dry seeds offer a variety of delicious confectionary snacks (papad,

mangodi, bhujia), as well as mature and immature green pods as vegetable consumption. Uttar Pradesh produces 100 tonnes from an area of 300 ha with an average productivity of 333 kg ha⁻¹ (Anonymous, 2010). Moth bean is generally grown on the less managed and neglected lands, which are extremely poor in physical properties and deficient in plant nutrients. Phosphorus is required for the conversion of essential biochemical reaction in plants and as a component of several key plant structural compounds. Amongst the several factors restricting the plant growth, phosphorus shortage is a recognized key obstacle in attaining the maximum yield potential of mothbean (Patel *et al.*, 2008). It is responsible for root growth and development as well as influencing nodulation in positive way. It also has a significant impact on energy storage and transport. Phosphorus is an integral part of nucleic acids (DNA and RNA) and most of enzymes involved in energy conversion in carbohydrate

metabolism and plant respiration. As nitrogen is fixed through symbiosis with *Rhizobium* bacteria, phosphorus fertilization for legumes is foremost than nitrogen. *Rhizobium* and Phosphate Solubilising Bacteria play a critical role in N_2 -fixation and P-solubilisation in soil. *Rhizobium* inoculation improves root nodulation by promoting root growth and increasing nutrient availability, leading in better nutrient uptake and use (Singh *et al.*, 2007). The PSB (Phosphate Solubilising Bacteria), dissolves interlocked phosphates in soil appears to have a significant impact on Indian agriculture. Dual inoculation of *Rhizobium* and PSB may benefit the plant in acquiring both nitrogen and phosphorus. Seed inoculation with *Rhizobium* and PSB has gathered a lot of attention to increase the availability of phosphate fixed in rhizosphere and to reduce fertilizer use (Chakrabarti *et al.*, 2007).

Hence, Phosphorus application in addition with biofertilizers inoculation (*Rhizobium* and PSB) in pulse crop provide easy access of nitrogen and phosphorus to the cropped plant. Phosphorus application along with biofertilizers creates a favourable environment for microorganism's proliferation in the rhizosphere that leads to easy nutrient assimilation by plants during their growth and developmental period.

Material and Methods

A field trial was conducted during the *Kharif* 2020, at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The experimental field's soil is neutral and deep, constituting a part of central Gangetic alluvium. It had sandy loam texture and contained medium nitrogen (N) and low phosphorus (P). The experiment was set up using Randomized Block Design with ten treatments that were replicated three times *viz.*, T_1 – control (farmer's practice 20-40-0 kg NPK/ha), T_2 - *Rhizobium*+20 kg P/ha, T_3 - *Rhizobium*+30 kg P/ha, T_4 - *Rhizobium*+40 kg P/ha, T_5 - PSB+20 kg P/ha, T_6 - PSB+30 kg P/ha, T_7 -PSB+40 kg P/ha, T_8 – (*Rhizobium*+PSB)+20 kg P/ha, T_9 – (*Rhizobium* +PSB)+30 kg P/ha, T_{10} – (*Rhizobium*+PSB)+ 40 kg P/ha. The experimental field was thoroughly ploughed, harrowed and brought to fine tilth and 30 plots each of 3.0 m x 3.0 m size were laid out according to layout design.

The inorganic fertilizers were applied as per treatment combination in the form of urea and SSP entire as basal dose. The seeds of moth bean (RMO-40) were sown in lines 30 cm apart at seed rate of 15 kg/ha. The seeds were treated with liquid *rhizobia* (10 ml/kg seeds) and liquid PSB (10 ml/kg seeds) as per the treatment combination and shade dried one hour before sowing. The growth parameters such as plant height (cm), number of branches (No.), number of nodules (No.), and dry weight per plant (g) were recorded at various growth stages while crop growth rate ($g/m^2/day$) was calculated by the methods described by Watson, 1947. The pods/plant, seeds/pod, test weight and seed yield were recorded at the time of harvest and averages were calculated and data was statistically analysed using ANOVA technique (Gomez and Gomez, 1984).



Figure 1: Measuring Plant height



Figure 2: Flowering and pod formation



Figure 3: Intercultural operation in field

Results and Discussion

Observation of Growth determining attributes viz., plant height, number of branches, number of nodules, and dry weight per plant presented in Table 1. Significantly highest plant height (21.09 cm) and number of branches (6.53) were recorded with seed inoculation by Rhizobia and PSB along with application of 30 kg P/ha over control. This could be owing to the combined effect of dual biofertilizers and phosphorus which increased nutrient availability during the crop growth. Haque and Khan (2012) and Rasool and Singh (2016) both reported similar results. At 45 DAS, maximum number of nodules per plant (16.93) has been recorded with combined inoculation of seed with Rhizobia and PSB and application of 30 kg P/ha over control. However, nodules per plant in Rhizobia+ PSB+40 kg P/ha (16.13) and in seed inoculation with PSB and basal dose of 30 kg P/ha (15.80) found on par with highest. This is due to synergistic effect of the Rhizobia and Phosphate Solubilising Bacteria for biological nitrogen fixation as opposed to their individual application. Similar results were also validated by Rudresh *et al.* (2005) and Tagore *et al.* (2013). This result might be due to the fact that when in Rhizobia and phosphate solubilizing bacteria are inoculated together, both microorganisms assist the plant in acquiring nitrogen and phosphorus. By supplying

assimilates to roots in the rhizosphere, phosphorus not only aids in proliferation and growth but also promotes nodulation and nitrogen fixation, reported by Puniya, 2010. The seed inoculation with Rhizobia and PSB along with basal dose of phosphorus @ 30 kg/ha recorded significantly higher dry weight per plant (5.481 g) over control, whereas seed inoculation by Rhizobia and PSB along with basal application of 40 kg P/ha (5.274 g), found statistically on par with highest. The higher dry weight per plant in T₉ might be due to increased availability of phosphorus results in increased plant vigour, number of new cells, and root growth, which speeds up the leaf development, aids in utilizing the radiant energy and nitrogen assimilation by plant. Similar findings were reported by Puniya (2010) and Iqbal (2018). During 45-60 DAS significant and higher crop growth rate (5.37 g/m²/day) was recorded with seed inoculation by Rhizobia and PSB and application of phosphorus @ 30 kg/ha, might be because of direct and higher translocation of nutrients during crop development stage, which enhances the physiological and metabolic activities of plant, allowing it to put up more growth by faster assimilation of the available nutrients and facilitate more photosynthesis and ultimately increase Crop Growth Rate (Kumawat *et al.*, 2017).

Table 1. Effect of phosphorus and biofertilizers on growth parameters of mothbean

Treatments	At Harvest			At 45 DAS	During 45-60 DAS
	Plant Height (cm)	Branches per plant(No.)	Dry weight (g plant ⁻¹)	Nodules per plant (No.)	CGR (g/m ² /day)
T ₁ : Control	18.25	5.27	4.224	12.27	4.26
T ₂ : Rhizobia + 20 kg P/ha	13.00	4.40	3.528	12.13	3.67
T ₃ : Rhizobia + 30 kg P/ha	16.36	4.60	3.884	14.27	3.85
T ₄ : Rhizobia + 40 kg P/ha	17.45	5.33	4.265	13.47	4.50
T ₅ : PSB + 20 kg P/ha	17.41	4.67	3.607	12.67	3.68
T ₆ : PSB + 30 kg P/ha	19.83	6.00	5.022	15.80	5.07
T ₇ : PSB + 40 kg P/ha	19.29	5.27	4.598	15.27	4.91
T ₈ : (Rhizobia + PSB) + 20 kg P/ha	18.87	5.93	4.426	13.13	4.61
T ₉ : (Rhizobia + PSB) + 30 kg P/ha	21.09	6.53	5.481	16.93	5.37
T ₁₀ : (Rhizobia + PSB) + 40 kg P/ha	20.98	6.20	5.274	16.13	5.12
S.Em (±)	0.63	0.15	0.143	0.50	0.52
CD (5%)	1.89	0.45	0.424	1.49	1.09

Table 2: Effect of phosphorus and biofertilizers on yield attributes and yield of mothbean

Treatments	Pods/plant (No.)	Seeds/pod (No.)	Test weight (g)	Seed yield (kg/ha)
T ₁ : Control	17.93	3.63	18.81	232.91
T ₂ : Rhizobia sps. + 20 kg P/ha	13.80	3.05	17.31	129.49
T ₃ : Rhizobia + 30 kg P/ha	14.67	3.46	17.97	176.32
T ₄ : Rhizobia + 40 kg P/ha	18.07	3.69	19.04	241.40
T ₅ : PSB + 20 kg P/ha	16.47	3.22	17.21	145.83
T ₆ : PSB + 30 kg P/ha	18.73	3.79	21.07	345.73
T ₇ : PSB + 40 kg P/ha	18.20	3.77	20.47	288.18
T ₈ : (Rhizobia + PSB) + 20 kg P/ha	18.47	3.69	19.79	269.65
T ₉ : (Rhizobia + PSB) + 30 kg P/ha	20.40	3.87	22.06	452.88
T ₁₀ : (Rhizobia + PSB) + 40 kg P/ha	19.60	3.83	21.66	430.51
S.Em (±)	0.72	0.05	0.29	12.39
CD (5%)	2.15	0.16	0.86	36.82

The observation related to yield attributing parameters were shown in Table 2. The pods/plant (20.40), seeds/pod (3.87) and test weight of seeds (22.06 g) were notably higher in T₉. The observed results of yield attributing parameters were attributed to phosphorus' regulatory activities in photosynthesis and glucose metabolism in leaves, which limit plant growth, especially during the reproductive phase. The observation of seed yield at the time of crop harvest is shown in Table 2. It shows significantly highest seed yield (452.88 kg ha⁻¹) in dual seed inoculation by biofertilizers with 30 kg P/ha, whereas seed yield in T₁₀ (Rhizobia+PSB+40 kg P/ha) (430.51 kg/ha), was found to be statistically on par with highest. The maximum seed yield in dual inoculation of biofertilizers and 30 kg P/ha application is due to

the collateral increament in pods/plant, seeds/pod and test weight under this treatment. This could be due to surplus assimilates being stored in the leaves and then translocated into seeds during senescence, resulting in increased seed yields. These findings are in agreement with Kumawat (2006).

Conclusion

In eastern plain zones of Uttar Pradesh, under inceptisol soil order, cultivation of mothbean with the application of phosphorus at the rate of 30 kg per hectare along with seed co-inoculation by Rhizobia and Phosphate Solubilising Bacteria was found to be more desirable in terms of increasing growth parameters, yield attributing parameters, seed yield of Mothbean crop during *Kharif* season.

Conflict of interest

The authors declare that they have no conflict of interest.

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