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# Studies on response of mung bean on phosphorous nutrition: A Review

## Sumana Balo

### Abstract
More than two-thirds of the world's soils are afflicted with phosphorus shortage (P). Agricultural output suffers because this phosphorus is unavailable to all but a tiny percentage of plants. To lessen the severity of the environmental impact, phosphorus-deficient soils have traditionally been fertilized. Improving agricultural management practices for sustainable crop output, including lowering phosphorus runoff, is the emphasis of this study. Investigating chemical fractionation mechanisms to distinguish between occluded P, acid-extractable calcium-bonded P, and non-occluded P is necessary for increasing Pi in mung bean (*Vigna radiata*) types and establishing net grazing systems. Phosphate (P) is known to be transferred between pools due to weathering, with the highest P retention rates found in clay-rich soils. Soil with a finer texture is better able to absorb and fix phosphorus, which means more nutrients and water can be made available to the plant when mung bean varieties are inoculated into it. More photosynthesis means more accumulated dry stuff. The P-treated variety of mung bean had the greatest yield index (13.28). Pods per plant (46.02), pods per crop (8.20), test weight (40.63 gm), pod weight (8.0 g), and seed weight (1.0 g) were all significantly increased with DAP (1.83 g). An increase in nodule count, leaf area index, plant height, grain yield, total chlorophyll content, and straw output of up to 40% was observed at higher P2O5 concentrations (2988 kilogrammes per hectare). Each plant developed the maximum number of nodules after receiving injections of PSB and Aspergillus awamori. The highest levels of chlorophyll were found in its leaves, and its plants were the largest and most productive overall. Liming improved mungbean yields in acid piedmont soil by raising the pH and altering other chemical characteristics. They claim that increasing India's output of pulses is necessary for the country to attain food security in the future. If farmers and extension workers want to see higher quality pulse yields and greater long-term profitability, they need to incorporate P nutrition into their balanced nutrient management programmes.

**Keywords:** Mungbean, phosphatic fertilizer, grain yield, photosynthetic yield; plant productivity

### Introduction
Phosphorus (P) is a macronutrient required by plants for its growth. It accounts for between 0.2 and 0.8 percent of the dry weight of a plant.Phosphorus is necessary for a wide variety of physiological and biochemical processes in plants. Phospholipids, nucleic acids, coenzymes, enzymes, and nucleotides include phosphorus (Mehrvaz *et al*., 2008) [17]. In the early stages of plant growth, enough P availability is also necessary for the laying down of the plant's reproductive parts' primordia (Satyaprakash *et al*., 2017; Kalayu, 2019) [21, 10]. The typical amount of phosphorus found in soil is 0.05 percent (w/w). However, only 0.1 percent of this phosphorus is available for plant uptake (Zhu *et al*., 2011) [30]. Phosphorus fertilizers have traditionally been used as a method for addressing phosphorus deficiency in the soil. To maintain consistent amounts of phosphorus in soil and plant systems, fertilizers in 52,3 billion tonnes are sprayed yearly (FAO, 2017) [5]. This tremendous quantity of phosphorus, which has been transformed into inorganic phosphorus and precipitated by metal cations in the soil such as iron, aluminium, magnesium, and calcium, is only used by plants at a rate of around 0.2 percent, or 10 micrograms (Soumare *et al*., 2020) [33]. The phosphate deposit in agricultural soils is sufficient to ensure that optimum crop production may be maintained worldwide for about 100 years (Kalayu, 2019) [10]. In addition, the use of fertilizers contributes to a variety of environmental problems, including the contamination of groundwater and the eutrophication of streams (Yu, *et al*., 2011 and Alori *et al*., 2017) [34, 35]. Agricultural management strategies need to be developed to improve the efficiency of phosphorus fertilization, increase crop productivity, and reduce environmental pollution caused by phosphorus loss from the soil. These goals will be achieved by reducing the amount of phosphorus loss from the soil.

**Importance of Phosphorus to Mungbean (leguminous crop)**

It is an essential mineral for plants, particularly pulse crops. Phosphorus encourages the growth of robust seedlings and broad root systems in plants. The formation of healthy nodules is dependent on many factors, one of which is the promotion of robust root growth.

**Basic information about mungbean crop**

In Indian agriculture, pulses have a special place. Green gram (*Vigna radiata* L.) is one of the most significant and widely farmed pulse crops today. It is estimated that India accounts for between 35 and 37 percent and 27 percent, respectively, of the total area and output of pulses worldwide. Many Asian nations, notably India and Pakistan, and Bangladesh and Sri Lanka, have large-scale cultivation of pulses (Swaminathan *et al*., 2012) [25]. India alone produces 14.76 million tonnes of pulses annually from a farmland area of 23.63 million acres with an average yield of 506 kg $ha^{-1}$. However, the local need for pulses necessitates the importation of around 2-3 million tonnes per year. Mungbean (*Vigna radiata*) is our country's most significant pulse crop. The Fabaceae (Papilionaceae) family of the order Leguminales includes mung bean, often known as moong or green gram. As a self-pollinating plant with a somatic chromosomal number of 2n = 2x = 22, it is very prolific. The seeds of the mung bean, which are high in protein, are farmed primarily for human use (Mondal *et al*., 2011) [18]. Mung bean protein is easily absorbed by the body, so it is often prescribed as a medical diet for those who suffer from flatulence. Aside from that, it's a good source of vitamin B and is often prescribed for beriberi. After being cooked, mungbean seeds, whole or divided, are consumed as Dal. Because of its extensive adaptability, low input requirements, and capacity to increase soil fertility via the use of symbiotic bacteria (Rhizobium found in root nodules), mung bean has emerged as a very profitable short-duration grain legume crop. Mixed, inter, and multiple cropping systems, as well as crop rotations using mung beans, have found this crop to be a good fit. The early maturation of this plant permits it to mature even in soils with low moisture content. It is possible to grow mung beans on soils with poor fertility and in areas with little water (Branch *et al*., 2017) [3].

**Fig 1:** Images of Mung bean.

**Table 1:** Classification of Mung Bean

| Kingdom | Plantae |
|---|---|
| B | Spermatophyta |
| Class | Dicotyledonae |
| Order | Leguminales |
| Family | Fabaceae (Papilionaceae) |
| Genus | Vigna |
| Species | *V. radiata* |

Beans like mung beans, also known as pulse crops or food legume crops, are often eaten dried from the seed, but they may also be used fresh as fodder or to prepare vegetables from the green pods and seeds (Uebersax, *et al*., 2022) [26]. It is possible to consume dried seeds in their whole or split form, boil them, ferment them, or mill and grind them into flour. Western nations and cultures often serve mung bean sprouts as a crunchy salad ingredient. Mung beans contain 20 to 24 percent protein mainly albumin and globulin. These two proteins account for more than 60 percent and 25 percent, respectively, of the total protein content of mung beans (Yi-Shen *et al*., 2018) [29]. Consuming mung beans in conjunction with cereals may, thus, greatly improve the quality of the protein provided by a meal.

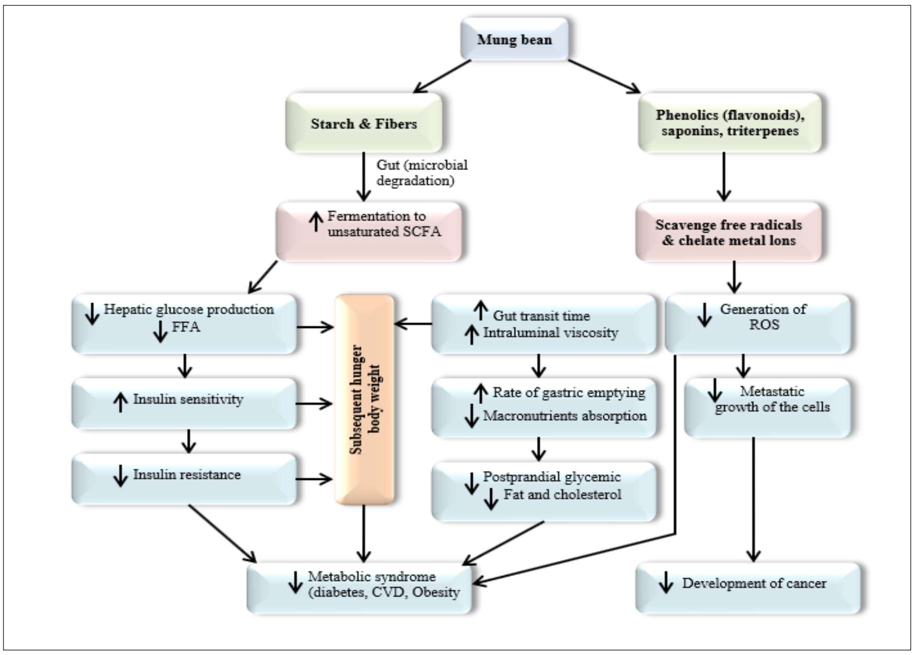


**Fig 2:** Mung beans and their health benefits:

**The impact of phosphorus on mung bean production**

The development and growth of a crop are heavily dependent on the establishment of a healthy root system early in the life cycle of crops. It has a significant role in the synthesis of chemicals with functions related to expansion, the development of roots and flowers, and maturation (Mahmud *et al*., 2020) [14]. In most cases, soils of have just traced amounts of the macronutrients and micronutrients that are accessible. In addition, the insufficiency of some macronutrients has developed in the nation because of the introduction of high-yielding cultivars, the increasing cropping intensity, and the extensive applications of nitrogenous and phosphorous fertilizers (Batjes *et al*., 1997) [2]. The application of the deficient macronutrient to the soil has been shown to have a positive impact on the yield of a variety of crops (Rasool *et al*., 2021) [20], and one of the key contributors to the decline in agricultural output is the inefficiency of phosphorus fertilizer, which is one of the most important nutrients for plant growth. Therefore, it is well recognized that phosphorus has an influence on the formation of roots (Hossain and Hamid, 2007) [9]. The addition of nitrogen and phosphorus fertilizer promotes root growth, which in turn increases the availability of other nutrients and water to the developing sections of the plant. This results in an enlarged photosynthetic area and, therefore, a higher accumulation of dry matter in the plant.

According to a finding, the addition of phosphorus to mungbean soil results in an increase in the amount of dry matter at harvest, the number of pods produced by each plant, the number of seeds produced by each pod, the seed yield, the weight of the grains, and the total biomass. The failure to add phosphorus to mungbean will, in the end, result in a reduction in both the production and the quality of the crop. DAP, SSP, and PROM, as well as PSB and Rhizobium biofertilizers on sandy soil, were used in an experiment performed by Kumawat (2013) [13] on mung bean in the Kharif season. It has been shown that using DAP as a phosphorus source has significantly increased the number of pods per plant (46.02), the number of pods per crop (8.20), the test weight (40.63 gm), the weight of a pod per crop, pod (8 g) and the weight of seed per pod (1.83 g).

To find out which phosphorus application level gave the best yield in the kharif season in the Madurai district of Tamil Nadu with Vylogam soil series, researchers Gayatri and Saravanapandian (2019) [31] carried out a field experiment with different phosphorus application levels in mung beans. There may have been a shift in the starch/sucrose ratio in plant source leaves and reproductive organs because of increased crop growth and an increased supply of phosphorus. This may be because of the positive effects of phosphorus on plant fruiting and the improved translocation of desirable metabolites to the yield-contributing sections of the plant. Straw production may have increased because of the fact that phosphorus tends to promote plant growth and development in terms of rhizosphere and plant system nutrition, which results in a greater metabolic rate and photosynthesis activity in plants.

It was shown that a lower rate of phosphorus application led to a greater amount of phosphorus recovery or agronomic efficiency than a higher rate of phosphorus application by either method (Shah *et al*., 2006) [32]. Fertilizing mungbean with organic manure, PSB and Phosphate significantly impacted its concentration of nutrients, their absorption, and their production. Inoculation of seeds with PSB and 40 kg $P_2O_5$/ha of vermicompost considerably enhanced the N, P, and K concentration in seed, straw, and total absorption, and protein content of mungbean, according to the results of this study (Kumawat *et al*., 2009) [12].

The application ofnitrogen and phosphorus per hectare produced the highest grain yield, the maximum number of nodules per plant, the plant height, the number of branches per plant, the number of pods per plant, the weight of 100 grains per pod, and simultaneously higher gross returns and a higher benefit-to-cost ratio than any other treatment in a different location (Singh *et al.*, 2011) [22].

$P_2O_5$ concentrations that reached up to 40 kg $ha^{-1}$ per plant (2988 kilograms per hectare) led to increases in nodule counts, leaf area index and plant height, grain yield and total chlorophyll content, and straw production. Inoculation with both PSB and *Aspergillus awamori* led to the maximum number of nodules produced by each plant, as well as the highest total chlorophyll content of leaves, plant height, as well as grain yield (Venkatarao *et al*., 2017) [28]. There was a significant increase in growth, yield, and quality with the combined treatment (80 kg $P_2O_5$ $ha^{-1}$) applied (Singh *et al*., 2018) [23].

The application of nutrients through 75 percent RDF + 2.5 t/ha vermicompost + Rhizobium + PSB was significantly better than other combinations in terms of plant height at harvest, yield attributes, protein percent, nutrient content, and uptake, followed by treatments of 100 percent RDF + 2.5 t/ha vermicompost and 100 percent RDF + PSB (Meena *et al.*, 2015) [16]. Even while bio-inorganic combinations can give all the nutrients needed by the soils to increase production, they may also producefavourable circumstances that allow crops to grow more efficiently. It may be possible to increase crop yields with the help of mutants that have lengthy pods and huge seeds. This would be accomplished by increasing both the number of seeds contained inside each pod and the size of the seeds themselves (Kumar *et al*., 2006) [32].

**Mung bean's reaction to phosphorus in the presence of lime**

Soil pH is a factor in determining how much phosphorus is available. In acidic soils, phosphorus combines with iron and aluminum to form phosphoric acid. As a result, it is inaccessible to plants. Soil pH may also make phosphorus unavailable because it combines with calcium, making it more difficult for the plant to absorb. There are techniques to increase the amount of phosphorus that plants can get. Addition of lime (Calcium hydroxide) decreases soil acidity. This may make phosphorous accessible to us that was previously locked up (Chen *et al*., 2003) [4]. Aside from the effects on phosphorus availability caused by liming, additional factors may have a role. The enzymes phosphatases are also known to affect the quantity of phosphorus accessible to plants. The sources of these enzymes (microbes, plant roots) might have changed the number or type of phosphatases produced in response to diverse fertilization histories. Phosphorus availability was very slightly increased in each instance. In the soils evaluated, lime alone was not enough to be relevant to crops and hence farmers. In these soils, lime must be supplemented with additional phosphorus (Margenot *et al*., 2016) [15].

Calcium and magnesium carbonates, oxides, hydroxides, and silicates are used in the liming process to remove rust.

Dolomite and calcite ($CaCO_3$-$MgCO_3$) are the most often used liming agents. Liming reactions begin with the neutralization of $H^+$ in the soil solution by either $OH^-$ or $HCO_3$. Adding lime to the soil is the most cost-effective way for resolving acidity. Several factors influence the amount of lime needed in a soil: pH, quality of lime, type of soil, agricultural method, and amount of rainfall. Crop growth and development benefit from proper liming. Calcium and magnesium are found in abundance in lime application. Improved nutrient solubility means plants have a richer source of nutrients. While reducing Al levels, lime increases soil pH, phosphorus availability, cation exchange capacity (CEC), and saturation of the bases. In addition, lime may increase the availability of Ca and Mg in soils.

Legumes are better able to fix nitrogen because the modulation mechanism has been improved (Speiser *et al*., 2000) [24]. To maintain a high yield in crops, liming also raises the acidity soil (pH), organic matter (OM), and plant nutrient availability. The release of P anions from Al- and Fe-(hydro) oxide surfaces is aided by increases in soil pH generated by adequate liming. Liming improves the availability of plant nutrients, notably P in the soil by promoting the mineralization of agricultural wastes and organic manure. Ca-phosphate precipitates more readily at higher pH, limiting soil P availability (Penn *et al*., 2019) [19]. Lime and organic matter must be added to acidic soils to prevent the harmful effects of Fe, Al, H, and Mn on crop development and fertilizer consumption. Fe, Al, or Mn (non-toxic) may be found in the soil if lime and organic matter are added to raise the pH level. In acidic soils, regular application of well-decomposed organic matter improves soil buffering ability, preventing rapid pH fluctuations. Acid soils benefit from this treatment because it enhances P availability and decreases the toxicity of Fe and Al.

The use of poultry manure (PM), cow dung (CD), compost, and lime may improve crop output, preserve soil fertility, and reduce soil acidity. It is necessary to discover the correct quantity of manure to raise the soil pH, fertility, and productivity of acidic soils. Sustainable crop production on acidic soils may benefit from lime usage in conjunction with organic and chemical fertilizers. One of the most important factors in guaranteeing long-term soil fertility and nutrient availability is the presence of soil organic matter (SOM). As an alternative supply of plant nutrients to chemical fertilizers, organic additions like CD and PM may retain soil fertility. CD and PM work together to enhance the soil's physical, chemical, and biological qualities, which ultimately leads to an increase in the nutrients that are available in the soil (Amaslu *et al*., 2020) [1].

There was no change in Truog extractable phosphate indexes with increasing lime additions, but there was an increase in Bray extractable indexes with increasing lime additions. Lime and P treatments enhanced legume P absorption and yield (Haynes and Ludecke, 1981) [7]. A rise in the mungbean crop's protein (percent), nutrient (percent), and total NPK absorption were found with the treatment of 200 kg lime/ha, as were results for all growth and yield indices (Varma *et al*., 2017) [27]. Another way in which roots might affect soil P concentrations is by the discharge of root exudates, such as organic ligands. The bioavailability of soil inorganic P in the rhizosphere may be affected by a variety of plant species, the nutritional state of plants, and the conditions of the soil; however, the relative contributions of these processes to the change in bioavailability can be very varied (Hinsinger *et al*., 2011) [8].

Liming had a significant effect on the overall seed output produced by each plant as well as the overall number of grains that were produced in each pod, the overall quantity of grain that was produced as well as the amount of grain that was produced per thousand seeds. According to the findings of the research, liming increases soil pH and changes other chemical properties of soil, both of which are beneficial for maintaining high yields of mungbean agriculture in the acid piedmont soil of North-East Bangladesh, which is in a region of the country where the pH rises and other chemical characteristics of soil are altered (Halim *et al*., 2014) [6].

## Conclusion

Phosphorus plays an important role in pulses nutrition mainly for mungbean production. Most of the Indian soils are deficient in phosphorus leading to affect the nutrition of pulse crop as pulses occupy an important position in food and nutritional security in India. India produces over 280 million tonnes of food grains every year with an increase of four folds since independence. Increased efforts to produce more food have resulted in tremendous shift in cropping systems towards cereal-cereal based systems. Accordingly, vision of Indian Institute of Pulse Research, 2030, the projected pulse requirement by the year 2030 would be 32 million tons with an anticipated required growth rate of 4.2%. The growing Indian population enhanced the pulses demand. The burgeoning human population in India needs higher pulses production for fulfilling the dietary protein requirement. It requires to mitigating the demand of protein. In this regard, balanced fertilization with NPK along with biofertilizers has been proved beneficial in pulses both under rainfed and irrigated conditions. Hence, phosphorous needs to be taken care of while balanced fertilization in pulses. A concerted effort by farmers, researchers, development agencies, and government are needed to ensure that India becomes self-sufficient in pulses in the future. Therefore, farmers and extension functionaries must recognize that it is highly needed to include P nutrition in their nutrient management practices in balanced manner in present day intensive farming to harvest higher pulse yields of superior quality earning maximum sustainable profitability.

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