Original Research Article

Effect of FYM, Phosphorus and PSB on Growth, Yield Attributes, Quality, Nutrient Content and Uptake of Mungbean [*Vigna radiata* (L.) Wilczek].

Abstract

A field experiment was carried out for two consecutive years (2020 and 2021) during *Kharif* season at Student's Instructional Farm (SIF) of Department of Agronomy, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh, India to assess the effect of FYM, phosphorus levels and PSB on growth and yield of Mungbean with variety Shweta (K.M. 2241) was laid out in Randomized Block Design (RBD) with factorial arrangement replicated thrice. The experimental have 20 treatment combinations, the levels of FYM *viz*., control (F_0), 1.0 t (F_1), 2.0 t (F_2) and 3.0 t (F_3) and levels of phosphorus *viz*., PSB only (P_1), 20 kg P_2O_5 (P_2), 20 kg P_2O_5 + PSB (P_3), 40 kg P_2O_5 (P_4) and 40 kg P_2O_5 + PSB (P_5). The result of this study showed the interaction effect of FYM and phosphorous & PSB were found non-significant. In the different levels of FYM, the 3.0 tons ha^{-1} FYM resulted in significantly higher growth attributes *viz*., plant height (40.60cm) at maturity, No. of branches $plant^{-1}$ (4.95) at maturity, number of nodules $plant^{-1}$ (24.85) at 60 DAS and dry weight of nodules $plant^{-1}$ (14.34) at 60 DAS, yield attributes *viz*., number of pods $plant^{-1}$ (14.70), weight of pod $plant^{-1}$ (7.44g), pod length (6.55cm) , and test weight (41.31g), yield *viz*. grain or seed yield (894kg ha^{-1}) and quality parameters *viz*., protein content (23.90%), protein yield (214kg ha^{-1}), nutrient contents in nutrients uptake by grain and straw of Mungbean compared to other treatments and control. Among the different levels of phosphorous & PSB, 40 kg P_2O_5 ha^{-1} + PSB resulted the highest values of growth attributes *viz*., plant height (38.54cm) at maturity, No. of branches $plant^{-1}$ (4.52) at maturity, number of nodules $plant^{-1}$ (23.19) at 60 DAS and dry weight of nodules $plant^{-1}$ (13.42) at 60 DAS, yield attributes *viz*., number of pods $plant^{-1}$ (13.99), weight of pod $plant^{-1}$ (6.57g), pod length (6.33cm), and test weight (40.85g), yield *viz*. grain or seed yield (825 kg ha^{-1}), and quality parameters *viz*., protein content (23.84%), protein yield (197kg ha^{-1}), nutrient contents in nutrients uptake by grain and straw. Thus, it is possible to maximize the growth attributes, yield attributes, yield and quality of Mungbean with application 3.0 tons ha^{-1} FYM and 40 kg P_2O_5 ha^{-1} + PSB.

Keywords: *FYM, Phosphorus, PSB, Quality, Uptake, Mungbean*

1. Introduction

Moongbean [*Vigna radiata* (L.) Wilcek] is an important pulse crop that is grown in India's dry and semi-dry areas. After chickpea and pigeon pea, Mungbean is the third most important pulse (Joshi & Saxena 2002). It is a short-duration *kharif* pulse crop that can also be grown between the *Rabi* and *Kharif* seasons as a "catch crop." It does pretty well in dry areas and can be grown on well-drained loamy to sandy loam soil in places where rain occurs occasionally. It can also be used as a green manure crop in the summer. Since it is a leguminous crop, it can fix nitrogen from the air. After the mature pods are taken off, the green plants are used as feed. It is a good source of protein (25%), and it has a lot of lysine (4600 mg/g N) and tryptophan (60 mg/g N). It can be eaten as a whole grain or as dal, which is a type of lentil, in different ways for food. Mung bean is thought to be easy to digest, so patients like to eat it. Ascorbic acid (vitamin C) is made when mung bean seeds are allowed to sprout. The amount of thiamine and riboflavin is also higher. In India, mungbean is grown on 34.37 million hectares and makes up 17.83 million tons of pulses (Anonymous, 2019-20). The important mungbean growing states are Rajasthan, Maharashtra, Karnataka, Madhya Pradesh, Gujrat, Tamil Nadu and Uttar Pradesh. In Uttar Pradesh, 0.49 million hectares were used to grow mungbeans, and 0.14 million tons were made each year (Anonymous, 2019-20). In India, raising livestock as part of a mixed farming system is an important part of growing crops, which is a business under the current conditions (Gill, *et al.*, 2009). Since there is a lot of FYM available and it is full of organic matter, it is important to add fertilizers to it. Green manuring seems hard to do in intensive cropping systems, so composting different kinds of organic waste is another good way to get organic manures. FYM has a lot of organic matter and is a good source of nutrients for plants. As it breaks down, it gives off organic acids and carbon dioxide, which help dissolve minerals and make them more accessible to plants. It helps soils stay stable when chemicals change quickly. FYM also gives microbes in the soil the energy they need to grow. It makes the soil better in terms of its physical, chemical, and biological properties. Brar *et al*. (2013) found that long-term use of FYM and fertilizers led to changes in the soil's physical properties, organic carbon, and the amount of nitrogen, phosphorus, and potassium that were available. By using FYM on farm crops, it doesn't have to be burned, which would be a waste. The amount of available phosphorus in Indian soils is low to average. Phosphorus doesn't move around in the soil, and only about 15–20% of the P that is added to a crop is used by that crop. While the rest stays in the soil in a fixed state that is affected by the soil's physical, chemical, and biological properties (Pouyat *et al.*, 2010). In addition to making P more soluble, these microorganisms can turn organic P into a form that is easy to dissolve. These reactions happen in the rhizosphere, and because the microorganisms put more P into solution than they need for their own growth and metabolism, the extra P is available for plants to take up. In a normal season, these bacteria can dissolve about 15-20 kg P_2O_5 ha^{-1}. It was found that adding them to the soil increased crop yield by 10-20% (Mazid & Khan 2015). Next to nitrogen, phosphorus is the second most important nutrient. Its lack is usually the single most important reason why pulse crops don't grow well on any soil. It makes up a big part of both proteins and nucleic acids. Phosphorus is an important part of the way energy-rich bound phosphates are made (ADP and ATP). It has a good effect on nodulation, stimulation, root development, growth, speeding up the time plants take to reach maturity, and improving the quality of their traits. So, it is more important than nitrogen in legumes because nitrogen is fixed by *Rhizobium* bacteria. Phosphorus (P) is one of the most important elements that plants need to grow and get bigger. P is in the soil in both its organic and inorganic forms. Most of the time, plants get P from soil solution in the form of inorganic P ($H_2PO_4^-$, $HPO_4^{2-)}$ (Awasthi *et al*., 2011). Some of the growth factors and processes that P affects in plants are seed germination, cell division, stem strength, flowering, fruiting, crop quality, synthesis of starch and fat, and many biochemical activities. In leguminous crops, P helps root nodulation, nitrogen fixation, nutrient use efficiency, efficient splitting of photosynthates between source and sink, and biomass production (Rao, 2009). After nitrogen (N), phosphorus (P) is the second most important macronutrient. Photosynthesis, energy storage and transfer, and stomatal conductance all need P. Its lack affects many metabolic processes, including slow plant growth, a weak root system, stems with a reddish colour, early leaf drop, and trouble setting fruit. It is important for the overall health and strength of plants, especially legumes. It makes legumes have more leghemoglobin and make them better at fixing nitrogen. It is also a key part of important molecules like nucleic acids, phospholipids, phosphoproteins, deoxyribonucleic acid (DNA), ribonucleic acid (RNA), adenosine diphosphate (ADP), and adenosine triphosphate (ATP) (Bunemann *et al*., 2011). Chemical fertilizers are an important source of nutrients, but their imbalance and long-term use have made the environment dirty and caused the physical and chemical properties of the soil to get worse. Another problem for farmers is that it's hard to find fertilizer at a price that makes sense. In this case, we need to come up with a system that uses fertilizer in a balanced way, along with organic manures that have many nutrients and low-cost bio fertilizer. The health of the soil is a big problem in agriculture right now. It's getting worse because farmers keep using chemicals on their crops and don't use organic fertilizers on their soil. They also don't grow pulse crops, which would help keep the soil healthy and keep it producing for a long time. FYM is a good source of nutrients for plants. It has substances that help plants grow and a number of beneficial microorganisms that do things like fix nitrogen, dissolve phosphorus, and break down cellulose. Phosphorus increases the grain yield of pulse crops by making the shoots grow and be more hardy. It also improves the quality of the seeds, controls photosynthesis, and helps the roots and nodules grow. The PSB also makes it easier for phosphorus to move from the soil into a form that plants can use. Keeping the above facts in view, the present investigation was planned and carried out at the SIF of C.S. Azad University of Agriculture and Technology, Kanpur during *kharif* seasons of 2020 and 2021 with the following objectives: to study the effect of FYM on growth, yield attributes and yield of Mungbean, To find out the effect of phosphorus with PSB on growth, yield attributes and yield of Mungbean, to see the interaction effect of the treatments, to evaluate the NPK content and their uptake in grain and straw.

2. Material and Method

At the Student's Instructional Farm of the C.S. Azad University of Agriculture and Technology, Kanpur, field tests were conducted in the *Kharif* seasons of 2020 and 2021. The experimental field had good drainage, was level, and used tube well for irrigation. Geographically speaking, Kanpur is located in the center of the Indian state of Uttar Pradesh at a height of 125.9 meters above mean sea level and latitudes of 25.26-28.58 ^{o}N and 79.31-80.34 ^{o}E. Before applying base fertilizer and FYM in both experiment years, soil samples from the experimental area were randomly collected from 0 to 15 cm of soil depth from various locations. Following thorough mixing of these samples, the appropriate soil sample was taken, and physio-chemical analysis was completed in the lab. The outcomes of the analytical effort are as follows: the soil texture was sandy loam, the soil pH was (7.7 and 7.8), the EC ds/m was (0.33 and 0.33), the organic carbon percentage was (0.41 and 0.42), and the available N kg/ha were (184.5 and 186.0), available P kg/ha (16.53 and 16.9), and available K (kg/ha) (149.36 and 151.3) for 2020 and 2021, respectively. The data on weather conditions that prevailed during the crop season of both years at the meteorological observatory located at the Student's Instructional Farm as the total rainfall received during crop season was 374.7 mm and 333.2 mm in 2020 and 2021, respectively. The weekly mean maximum and minimum temperature during the crop season ranged from 32.3 - 35.1 ^{0}C and 20.6 - 27.8 ^{0}C in 2020 and 31.5 - 34.5 ^{0}C and 22.7 - 27.6 ^{0}C in 2021, respectively. The average relative humidity ranged from 33.92 % in 2020 and 45.73 % in 2021. The experiment was laid out in Factorial Randomized Block Design with three replications. In all twenty treatment combinations of two factors (FYM, Phosphorus and PSB) with 4 and 5 levels were tested during both years. Factor A - Levels of FYM (t ha^{-1}) - 4 F_0-Control, F_1 - 1.0, F_2 - 2.0, F_3 - 3.0, Factor B – Levels of phosphorus (kg ha^{-1}) - 5 P_1 - PSB only, P_2 - 20 kg P_2O_5, P_3 - 20 kg P_2O_5 +PSB, P_4 - 40 kg P_2O_5, P_5- 40 kg P_2O_5 +PSB with Net plot size of 3.60 m x 2.60 m = 9.36 m^2. Where, Shweta variety of Mungbean was selected for experiment during both years. It is a short duration variety developed by C.S. Azad University of Agriculture & Technology, Kanpur in 2013. It is short stature, yielding (10-12 q/ha) with shining seeds and greenish appearance, matures in 60-65 days. Crop was sown in lines 45 cm apart with plant to plant distance of 10 cm using 15 kg ha^{-1} seed.

Plant height was measured from ground surface to the base of apical leaf of tagged plants from each plot and average plant height was worked out. Total number of branches was counted on tagged plants and average number of branches per plant was calculated. Number of nodule was counted on the roots of five sampled plants at 30 and 60 DAS and averaged for number of nodules/plant. Nodules collected from five sample plants were dried in open for two days and transferred to oven at 65^0 C for 36 hours and weight of nodules was recorded and averaged. Yield attributes and yield *viz.* total number of pods was counted on tagged plants and averaged for number of pods/plant. Total pods were collected from five tagged plants, weighted and averaged for recording mean pod weight per plant. Length of pods was recorded on five tagged plants and averaged for length/pod. One thousand grain from each sample were collected at the time of threshing, counted and weighted from the point of view to record thousand grain weight. After winnowing and cleaning, seed produce of each net plot was weighed on digital balance in kg which was computed into q/ha with the help of conversion factor of 10.6823. Quality parameter viz. Protein content in seed of each plot was worked out by multiplying nitrogen percent of seed with 6.25 **(**A.O.A.C., 1960). Nutrient content (%) and Nutrient uptake (kg ha^{-1}) by crop viz. Nitrogen, phosphorus and potassium content were worked out in plant produce (grain and straw) of five tagged plants taken for the yield attributing characters and yield. Oven dried plant samples were ground with the help of Wiley Mill Grinder. Total nitrogen phosphorus and potassium content were determined using modified Kjeldahl, spectrophotometry, and flame photometric, turbid metric and carmine method, respectively. The amount of nutrient taken up by seed, Stover calculated by multiplying their nutrient content with corresponding oven dry weight and dividing it by 100 and expressed as nutrient uptake by seed and Stover and both added to calculate total nutrient uptake.

3. Result and Discussion

3.1 Growth Attributes:

The data presented in Table 1 plant height, No. of branches $plant^{-1}$ at maturity, number of nodules $plant^{-1}$ 60 DAS and dry weight of nodules $plant^{-1}$ 60 DAS showed significant result with different levels of FYM, Phosphorus & PSB, however the interaction effect was non-significant. The higher growth attributes *viz.*, plant height (40.60 cm) at maturity, No. of branches $plant^{-1}$ (4.95) at maturity, number of nodules $plant^{-1}$ (24.85) at 60 DAS and dry weight of nodules $plant^{-1}$ (14.34) at 60 DAS was recorded with application FYM @ 3.0 tons ha^{-1} over rest of treatment. This may be due to easily availability of macro and micro nutrient which may have helped in growth attribute of Mungbean. Similar finding also confirmed with (Meena *et. al*., 2016) (Rekha *et al*., 2018), Banotra *et al*., 2021). Among the different levels phosphorous & PSB higher plant height (38.54 cm) at maturity, No. of branches plant^{-1} (4.52) at maturity, number of nodules plant^{-1} (23.19) at 60 DAS and dry weight of nodules plant^{-1} 13.42 at 60 DAS was recorded with application phosphorous @ 40 kg P_2O_5+ PSB ha^{-1} over rest of treatment. Maduku *et al. (*2008) and Singh *et al.* (2015) also pointed out that phosphorus and PSB is good for plant growth, nodulation, and root development. Because there was more nodulation when there was more phosphorus, bacteria that fix nitrogen might have been able to make enough nitrogen and help Mungbean grow better (Choudhary *et al.*, 2014 and Kumar and Yadav 2018). In addition to making nodules better, higher P levels seem to have caused the canopy to grow bigger, which seems to have made it better at absorbing and using radiant energy. This led to more effective and total nodules (Tiwari and Kumar 2009 and Verma *et al*., 2017). This leads to overall growth and development of Mungbean.

3.2 Yield Attributes:

Data as depicted in Table 2 showed that application of different levels of FYM and phosphorous & PSB influenced yield attributes *viz.*, number of pods plant^{-1}, weight of pod plant^{-1} (g), pod length (cm) and test weight (g) of Mungbean, however the interaction effect was non-significant. The significantly higher yield attributes *viz.*, number of pods plant^{-1}14.70, weight of pod plant^{-1} (7.44g), pod length (6.55cm), and test weight (41.36g) were recorded with application FYM @ 3.0 tons ha^{-1} over rest of treatment. This may be as a result of increased vegetative development in terms of dry matter and the quantity of branches per plant, which gave more locations for photosynthesizing molecules to move to and ultimately led to an increase in the number of yield attributes. The increased supply of macro- and micronutrients during the entire growing season is likely what caused FYM to have a positive impact on yield attributes. It might have been caused by increased food production and subsequent sink partitioning. In turn, this led to an increase in the number of pods per plant, the weight of the pod per plant (g), the length of the pod, and the test weight. The availability and optimal supply of nutrients to plants positively influenced the blooming and grain formation. Similar results were also reported by Kumawat *et al*., 2009 (singh *et. al*., 2017), (Rekha *et al*., 2018). Among different levels of Phosphorous & PSB was recorded maximum yield attributes *viz.*, number of pods plant^{-1}(17.78), weight of pod plant^{-1} (6.57g), pod length (6.35cm), and test weight (40.85g) with application phosphorous @ 40 kg P_2O_5+ PSB ha^{-1} over rest of treatment. The higher yield attribute could be because there was enough phosphorus and PSB during the early stages of growth. This led to better vegetative growth, which increased the sink for flowering and setting grain. Because the plants grew taller, had more branches, and made more dry biomass, they were able to hold more weight. This made Mungbean stronger. Finding were similar to (Verma *et. al*., 2017), (Singh *et al*., 2018), (Sharma *et al*., 2021), (Singh *et al*., 2022), (Kumar *et al*., 2022).

3.3 Yield:

The data presented in Table 3 revealed that the Grain or Seed yield significantly increased with different levels of FYM, phosphorous & PSB in Mungbean, however the interaction effect was non-significant. Maximum grain yield (894 Kg ha^{-1}) was recorded with application FYM @ 3.0 tons ha^{-1} over rest of treatment. It is well established that seed yield of a crop is a function of yield attributes such as pods/plant and seeds/pod. Increase in these yield attributes due to fertilization might have increased grain yield of Mungbean Which may be due to proper uptake of nutrient and favorable condition for development of grain. Result confirms with (Kumawat *et* *al*., 2009), (Rekha *et al*., 2013).Among different levels of Phosphorous & PSB was recorded maximum grain yield 825 (kg ha^{-1}) with application phosphorous @ 40 kg P_2O_5+ PSB ha^{-1} over rest of treatment. The increase might be due to application of higher phosphorus & PSB which provide favorable condition for growth and better development of plant which increases the yield of Mungbean. Overall increase in growth, growth attribute helped in increasing the yield of Mungbean. Similar result was also reported by (Malik *et al*., 2013), (Singh *et al*., 2010), (Singh *et al*., 2018).

3.4 Quality Parameters and nutrient uptake:

A perusal of data on quality parameters *viz*., protein content (%), protein yield (kg ha^{-1}), nutrient contents in Grain (%), nutrient contents in Straw (%), nutrients uptake by Grain (kg ha^{-1}) and nutrients uptake by Straw (kg ha^{-1}) as presented in Table 3,4 & 5) that showed significant results with different levels of FYM and phosphorous & PSB in Mungbean, however the interaction effect was non-significant. The maximum quality parameters *viz*., protein content (23.90%), protein yield (214 kg ha^{-1}), nutrient contents in Grain (3.85, 0.55, 0.87%), nutrient contents in Straw (1.32, 0.22, 1.72%), nutrients uptake by Grain (34.38, 4.87, 7.78 kg ha^{-1}) and nutrients uptake by Straw (34.38, 4.87, 7.78 kg ha^{-1}) were found with application FYM @ 3.0 tons ha^{-1} over rest of treatment. The increased uptake with the application of FYM might be due to enhanced effect of Rhizobium in nitrogen supply (Otieno *et al*., 2009). The increased uptake of P by phosphobacteria (Bacillus) could be attributed to its greater P-solubilization potentiality in the presence of organic matter. Organic fertilizer provides significant cation exchange capacity to hold cations such as K^+. The change in cation exchange capacity of organics by acidification might have enhanced K availability, Which may have increased the quality of Mungbean. Similar result also confirms with (Kumawat *et al*., 2009), (Singh *et al*., 2017). Among different levels of Phosphorous & PSB maximum protein content (23.84%), protein yield (197 kg ha^{-1}), nutrient contents in Grain (3.85,055,0.87%), nutrient contents in Straw (1.32, 0.22,1.72%), nutrients uptake by Grain (31.58, 4.34, 7.17 kg ha^{-1}) and nutrients uptake by Straw (31.58, 4.34, 7.17kg ha^{-1}) were recorded with application phosphorous @ 40 kg P_2O_5+ PSB ha^{-1} over rest of treatment. The increase in protein content (%) might be due to application of high doses of phosphorous & PSB which create favorable condition to uptake of higher amount of nutrient specially more nitrogen uptake which increased the protein content (%), protein yield (kg ha^{-1}), nutrient contents in Grain (%), nutrient contents in Straw (%), nutrients uptake by Grain (kg ha^{-1}) and nutrients uptake by Straw (kg ha^{-1}). The results agreement with those by (Singh *et al*., 2018). Application Phosphorus and PSB increased overall uptake of phosphorus and PSB and Nitrogen, phosphorus which increased overall increase in quality of Mungbean. The maximum value of all these characters was observed in 40 kg P_2O_5+PSB. Finding also confirms with (Dhakal *et. al*., 2016), (Rekha *et al*., 2018), (Patel *et. al*., 2019).

Table 1 Effect of FYM, Phosphorus and PSB on Growth Attributes of Mungbean

Treatments	Plant height (cm) at Maturity			No. of branches/plant at maturity			No. of nodules/plant at 60 DAS			Dry weight of nodules/plant (g) at 60 DAS		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Level of FYM t ha^{-1}												
F_1 - 0 t ha^{-1}	35.07	35.12	35.10	3.90	3.91	3.91	19.73	19.78	19.76	11.91	11.99	11.95
F_2 -1 t ha^{-1}	36.13	36.42	36.27	4.18	4.15	4.16	21.69	21.74	21.71	12.79	12.76	12.77
F_3 - 2 t ha^{-1}	38.68	38.68	38.68	4.48	4.47	4.48	23.18	23.21	23.20	13.27	13.26	13.27
F_3 - 3 t ha^{-1}	40.55	40.65	40.60	4.94	4.96	4.95	24.55	25.14	24.85	14.34	14.34	14.34
SEd ±	0.415	0.460	0.306	0.082	0.099	0.063	0.250	0.267	0.180	0.169	0.196	0.128
CD at 5%	0.840	0.932	0.606	0.166	0.200	0.125	0.506	0.540	0.357	0.342	0.396	0.253
Level of Phosphorus												
P_1- PSB	36.42	36.45	36.44	4.14	4.15	4.15	21.48	21.49	21.48	12.63	12.69	12.66
P_2- 20 Kg P_2O_5	37.33	37.63	37.48	4.36	4.35	4.35	21.90	21.96	21.93	12.85	12.76	12.80
P_3 -20 Kg P_2O_5+ PSB	37.73	37.89	37.81	4.39	4.39	4.39	22.30	22.56	22.43	13.06	13.17	13.11
P_4- 40 Kg P_2O_5	38.03	38.08	38.06	4.47	4.46	4.46	22.70	23.04	22.87	13.42	13.42	13.42
P_5- 40 Kg P_2O_5+ PSB	38.53	38.55	38.54	4.52	4.51	4.52	22.07	23.31	23.19	13.43	13.41	13.42
SEd ±	0.464	0.514	0.342	0.092	0.110	0.071	0.279	0.298	0.202	0.189	0.219	0.143
CD at 5%	0.939	1.042	0.677	0.185	0.223	0.140	0.566	0.604	0.399	0.382	0.443	0.282

Table 2 Effect of FYM, Phosphorus and PSB on Yield Attributes of Mungbean

Treatments	Number of Pods/Plant			Weight of pod/plant (g)			Pod length (cm)			Test weight (g)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Level of FYM t ha^{-1}												
F_1 - 0 t ha^{-1}	11.64	11.75	11.70	4.54	4.54	4.55	5.72	5.80	5.76	40.12	40.13	40.13
F_2 -1 t ha^{-1}	13.49	13.58	13.54	4.63	5.60	5.62	5.95	5.97	5.96	40.29	40.30	40.30
F_3 - 2 t ha^{-1}	13.94	14.10	14.02	6.44	6.42	6.43	6.23	6.25	6.24	40.73	40.75	40.74
F_3 - 3 t ha^{-1}	14.54	14.86	14.70	7.46	7.43	7.44	6.54	6.56	6.55	41.35	41.36	41.36
SEd ±	0.188	0.198	0.135	0.170	0.185	0.124	0.030	0.059	0.033	0.113	0.087	0.071
CD at 5%	0.381	0.401	0.267	0.344	0.375	0.246	0.060	0.119	0.065	0.228	0.175	0.140
Level of Phosphorus												
P_1- PSB	12.85	12.98	12.91	5.31	5.32	5.31	5.82	5.91	5.87	40.30	40.31	40.31
P_2- 20 Kg P_2O_5	13.06	13.19	13.13	5.84	5.82	5.83	6.05	6.07	6.06	40.58	40.59	40.59
P_3 -20 Kg P_2O_5+ PSB	13.54	13.73	13.63	6.07	6.03	6.05	6.13	6.15	6.14	40.64	40.65	40.65
P_4- 40 Kg P_2O_5	13.68	13.88	13.78	6.29	6.27	6.28	6.21	6.23	6.22	40.76	40.78	40.77
P_5- 40 Kg P_2O_5+ PSB	13.89	14.10	13.99	6.58	6.55	6.57	6.34	6.36	6.35	40.84	40.86	40.85
SEd ±	0.210	0.221	0.151	0.190	0.207	0.139	0.033	0.066	0.037	0.126	0.097	0.079
CD at 5%	0.426	0.448	0.299	0.384	0.419	0.275	0.067	0.134	0.072	0.255	0.196	0.167

Table 3 Effect of FYM, Phosphorus and PSB on Yield, Quality of Mungbean

Treatments	Grain Yield (kg ha^{-1})			Protein content (%)			Protein yield (kg ha^{-1})		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Level of FYM t ha^{-1}									
F_1 - 0 t ha^{-1}	615	616	616	23.72	23.73	23.73	146	146	146
F_2 -1 t ha^{-1}	697	701	699	23.76	23.77	23.77	166	167	166
F_3 - 2 t ha^{-1}	825	793	809	23.81	23.82	23.81	196	193	195
F_3 - 3 t ha^{-1}	996	891	894	23.89	23.90	23.90	214	213	214
SEd ±	17.9	20.8	13.5	0.033	0.035	0.024	2.5	2.9	2.0
CD at 5%	36.3	42.0	26.8	0.066	0.070	0.048	5.1	5.9	3.9
Level of Phosphorus									
P_1- PSB	665	666	666	23.75	23.76	23.76	158	159	158
P_2- 20 Kg P_2O_5	734	712	723	23.77	23.78	23.78	175	174	174
P_3 -20 Kg P_2O_5+ PSB	766	761	764	23.80	23.80	23.80	182	181	182
P_4- 40 Kg P_2O_5	799	790	795	23.82	23.83	23.82	191	188	189
P_5- 40 Kg P_2O_5+ PSB	828	823	825	23.84	23.85	23.84	198	197	197
SEd ±	20.1	23.2	15.1	0.036	0.039	0.027	2.8	3.3	2.2
CD at 5%	40.6	47.0	30.0	0.0740	0.078	0.054	5.8	6.6	4.4

Table 4 Effect of FYM, Phosphorus and PSB on Nutrient Content of Mungbean

Treatments	Nutrient contents in Grain (%)									Nutrient contents in Straw (%)								
	Nitrogen content			Phosphorus content			Potassium content			Nitrogen content			Phosphorus content			Potassium content		
	2020	**2021**	**Pooled**	**2020**	**2021**	**Pooled**	**2020**	**2021**	**Pooled**	**2020**	**2021**	**Pooled**	**2020**	**2021**	**Pooled**	40.12	40.13	40.13
Level of FYM t ha^{-1}																		
F_1 - 0 t ha^{-1}	3.76	3.77	3.77	0.46	0.48	0.47	0.84	0.84	0.85	1.26	1.27	1.27	0.19	0.19	0.19	1.66	1.67	1.67
F_2 -1 t ha^{-1}	3.78	3.79	3.79	0.47	0.49	0.48	0.85	0.85	0.85	1.27	1.29	1.28	0.20	0.20	0.20	1.68	1.69	1.68
F_3 - 2 t ha^{-1}	3.79	3.80	3.80	0.49	0.50	0.50	0.86	0.86	0.86	1.28	1.30	1.29	0.21	0.21	0.21	1.69	1.70	1.70
F_3 - 3 t ha^{-1}	3.84	3.85	3.85	0.55	0.54	0.55	0.87	0.87	0.87	1.31	1.32	1.32	0.22	0.23	0.22	1.72	1.73	1.72
SEd ±	0.012	0.012	0.008	0.008	0.008	0.006	0.006	0.006	0.004	0.009	0.010	0.007	0.004	0.005	0.003	0.008	0.009	0.006
CD at 5%	0.024	0.023	0.016	0.017	0.017	0.011	0.013	0.013	0.007	0.017	0.021	0.013	0.008	0.010	0.007	0.017	0.019	0.013
Level of Phosphorus																		
P_1- PSB	3.77	3.78	3.78	0.47	0.48	0.47	0.85	0.85	0.85	1.27	1.28	1.27	0.19	0.20	0.19	1.68	1.69	1.68
P_2- 20 Kg P_2O_5	3.79	3.80	3.80	0.48	0.50	0.49	0.85	0.85	0.85	1.27	1.28	1.27	0.20	0.20	0.20	1.68	1.69	1.68
P_3 -20 Kg P_2O_5+ PSB	3.80	3.81	3.81	0.49	0.51	0.50	0.86	0.86	0.86	1.28	1.30	1.29	0.21	0.21	0.21	1.69	1.70	1.69
P_4- 40 Kg P_2O_5	3.81	3.82	3.82	0.51	0.52	0.51	0.86	0.86	0.86	1.29	1.31	1.30	0.21	0.21	0.21	1.70	1.71	1.70
P_5- 40 Kg P_2O_5+ PSB	3.82	3.83	3.83	0.52	0.53	0.52	0.87	0.87	0.87	1.30	1.32	1.31	0.22	0.22	0.22	1.70	1.72	1.71
SEd ±	0.014	0.013	0.010	0.009	0.009	0.007	0.007	0.007	0.004	0.010	0.012	0.008	0.005	0.006	0.004	0.009	0.011	0.007
CD at 5%	0.027	0.026	0.019	0.018	0.018	0.013	0.014	0.014	0.008	0.019	0.024	0.015	0.009	0.011	0.007	0.019	0.021	0.014

Table 5 Effect of FYM, Phosphorus and PSB on Nutrient Uptake of Mungbean

Treatments	Nutrients uptake by Grain (kg ha^{-1})									Nutrients uptake by Straw (kg ha^{-1})								
	Nitrogen			Phosphorus			Potassium			Nitrogen			Phosphorus			Potassium		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Level of FYM t ha^{-1}																		
F_1 - 0 t ha^{-1}	23.16	23.25	23.20	2.85	2.96	2.90	5.16	5.18	5.17	23.16	23.25	23.20	2.85	2.96	2.90	5.16	5.18	5.17
F_2 -1 t ha^{-1}	26.36	26.58	26.47	3.30	3.44	3.37	5.93	5.96	5.95	26.36	26.58	26.47	3.30	3.44	3.37	5.93	5.96	5.95
F_3 - 2 t ha^{-1}	31.28	30.75	31.01	4.02	4.09	4.06	7.08	6.94	7.01	31.28	30.75	31.01	4.02	4.09	4.06	7.08	6.94	7.01
F_3 - 3 t ha^{-1}	34.43	34.34	34.38	4.94	4.81	4.87	7.82	7.74	7.78	34.43	34.34	34.38	4.94	4.81	4.87	7.82	7.74	7.78
SEd ±	0.469	0.557	0.359	0.163	0.150	0.110	0.277	0.254	0.186	0.469	0.557	0.359	0.163	0.150	0.110	0.277	0.254	0.186
CD at 5%	0.949	1.127	0.711	0.330	0.304	0.317	0.562	0.515	0.368	0.949	1.127	0.711	0.330	0.304	0.317	0.562	0.515	0.368
Level of Phosphorus																		
P_1- PSB	25.05	25.16	25.10	3.10	3.17	3.14	5.63	5.64	5.63	25.05	25.16	25.10	3.10	3.17	3.14	5.63	5.64	5.63
P_2- 20 Kg P_2O_5	27.81	27.81	27.81	3.58	3.65	3.62	6.21	6.20	6.21	27.81	27.81	27.81	3.58	3.65	3.62	6.21	6.20	6.21
P_3 -20 Kg P_2O_5+ PSB	29.10	28.99	29.05	3.81	3.82	3.81	6.56	6.52	6.54	29.10	28.99	29.05	3.81	3.82	3.81	6.56	6.52	6.54
P_4- 40 Kg P_2O_5	30.43	30.17	30.33	4.09	4.12	4.10	6.89	6.80	6.84	30.43	30.17	30.33	4.09	4.12	4.10	6.89	6.80	6.84
P_5- 40 Kg P_2O_5+ PSB	31.65	31.52	31.58	4.31	4.37	4.34	7.20	7.13	7.17	31.65	31.52	31.58	4.31	4.37	4.34	7.20	7.13	7.17
SEd ±	0.524	0.622	0.402	0.182	0.186	0.122	0.310	0.284	0.208	0.524	0.622	0.402	0.182	0.186	0.122	0.310	0.284	0.208
CD at 5%	1.061	1.260	0.795	0.369	0.340	0.242	0.628	0.575	0.411	1.061	1.260	0.795	0.369	0.340	0.242	0.628	0.575	0.411

4. CONCLUSION

The results obviously suggest and it may be concluded that application of FYM and phosphorous & PSB on Mungbean variety Shweta significantly change plant morphology, improvement in vegetative and reproductive growth to enable them for higher plant growth, yield attributes, yield and quality of Mungbean. On the basis of results obtained during course of investigation, the level of FYM @ 3.0 tons ha^{-1} and phosphorous @ 40 kg P_2O_5+ PSB ha^{-1} proved to be the most promising in growth attributes, yield attributes, yield and quality compared to other treatments and control.

REFERENCES

A.O.A.C. (1960). Official Methods of Analysis (9th ed.) Association of Official Agricultural Chemists. Washington, D. C.

Anonymous, (2019-20). Directorate of Economics and Statistics, DAC&FW, Ministry of Agriculture & Farmers Welfare, Government of India, New Delhi. *Agricultural Statistics at a glance.*

Awasthi, R., Tewari, R., & Nayyar, H. (2011). Synergy between plants and P-solubilizing microbes in soils: effects on growth and physiology of crops. *International Research Journal of Microbiology*, *2*(12), 484-503.

Banotra, M., Sharma, B. C., Nandan, B., & Kumar, R. (2021). Effect of Differential Substitution of Nutrients through Organics on Growth, Quality, Nutrient Uptake and Economics of Mungbean (*Vigna radiata*) in Shiwalik Foothill Region. *Legume Research-An International Journal*, *1*, 7.

Brar, B. S., Singh, K., & Dheri, G. S. (2013). Carbon sequestration and soil carbon pools in a rice–wheat cropping system: effect of long-term use of inorganic fertilizers and organic manure. *Soil and Tillage Research*, *128*, 30-36.

Bünemann, E. K., Prusisz, B., & Ehlers, K. (2011). Characterization of phosphorus forms in soil microorganisms. In *Phosphorus in Action* (pp. 37-57). Springer, Berlin, Heidelberg.

Choudhary A, Yadav BL Choudhary S, and Puniya MM. 2014. Response of integrated phosphorus management on nodulation and productivity of mungbean on Typic Ustipasamment. *Green farming*. 5 : 222-225.

Dhakal, Y., Meena, R. S., & Kumar, S. (2016). Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of Mungbean. *Legum res*, *39*(4), 590-594.

Gill, M. S., Singh, J. P., & Gangwar, K. S. (2009). Integrated farming system and agriculture sustainability. *Indian Journal of Agronomy*, 54(2), 128-139.

Joshi, P. K., & Saxena, R. (2002). A profile of pulses production in India: Facts, trends and opportunities. *Indian Journal of Agricultural Economics*, 57(3), 326-339.

Kumar S and Yadav SS. 2018. Effect of Phosphorus Fertilization and Bio-organics on Growth, Yield and Nutrient Content of Mungbean (*Vigna radiata (L.*). *Research Journal of Agricultural Sciences* .9(6): 1252-1257.

Kumar, P., Kumar, S., Kumar, V., Dixit, V., Verma, S., & Singh, V. (2022). Zn and B Mediated Effect on Yield Attribute, Yield, and Nutrient Uptake in Lentil (*Lens culinaris* Medick.). *International Journal of Plant & Soil Science*, 34(22), 1045-1055. https://doi.org/10.9734/ijpss/2022/v34i2231468.

Kumawat, N., Kumar, R., & Sharma, O. P. (2009). Nutrient uptake and yield of mungbean [*Vigna radiata* (L.) Wilczek] as influenced by organic manures, PSB and phosphorus fertilization. *Environ Ecol*, *27*(4B), 2002-2005.

Maduku DK, Christo IEC and Onuh MO. (2008). Effect of organic manure and cowpea (*Vigna unguiculata* (L.) varieties on the chemical properties of the soil and root nodulation. *Science World Journal*.3: 43-46

Malik, J. K., Singh, R., Thenua, O. V. S., & Kumar, A. (2013). Response of pigeonpea (*Cajanus cajan*)+ mungbean (*Phaseolus radiatus*) intercropping system to phosphorus and biofertilizers. *Legume Res*, *36*(4), 323-330.

Mazid, M., & Khan, T. A. (2015). Future of bio-fertilizers in Indian agriculture: an overview. *International Journal of Agricultural and Food Research*, *3*(3).

Meena, S., Swaroop, N., & Dawson, J. (2016). Effect of integrated nutrient management on growth and yield of Mungbean (*Vigna radiata* L.). *Agricultural Science Digest*, *36*(1), 63-65.

Otieno, P. E., Muthomi, J. W., Chemining'wa, G. N., & Nderitu, J. H. (2009). Effect of rhizobia inoculation, farm yard manure and nitrogen fertilizer on nodulation and yield of food grain legumes. *J Krishi Vigyan* 2017, 5(2): 39-45.

Patel, B. N., Patel, K. H., Singh, N., & Shrivastava, A. (2019). Effect of phosphorus, FYM and bio-fertilizer on growth, yield attribute, yield and quality of summer Mungbean (*Vigna radiate* L.). *Journal of pharmacognosy and phytochemistry*, *8*(5), 1108-1112.

Pouyat, R. V., Szlavecz, K., Yesilonis, I. D., Groffman, P. M., & Schwarz, K. (2010). Chemical, physical, and biological characteristics of urban soils. *Urban ecosystem ecology*, *55*, 119-152.

Rao, I. M. (2009). Essential plant nutrients and their functions. *CIAT* working Document No.209.

Rekha, K., Pavaya, R. P., Neha, C., & Patel, S. (2018). Effect of FYM, Phosphorus and PSB on Growth, Yield and Quality of Mungbean [*Vigna radiata* (L.) Wilckzek] on Loamy Sand. *International Journal of Bio-resource and Stress Management*, *9*(2), 220-223.

Sharma, A., Pathania, P., & Sharma, M. (2021). Effect of PSB, FYM with variable levels of P on the yield attributes and productivity of black gram in Shiwalik hills of Himachal Pradesh. *FOOD*

LEGUMES, *34*(1), 31-37.

Singh K, Manohar RS, Choudhary R, Yadav AK and Sangwan A. (2015). Response of different sources and level of phosphorus on yield, nutrient uptake and net return on mungbean under rainfed condition. *Indian Journal of Agriculture Research* 35: 2015: 263-268.

Singh, G., Sekhon, H. S., Ram, H., & Sharma, P. (2010). Effect of farmyard manure, phosphorus and phosphate solubilizing bacteria on nodulation, growth and yield of kabuli chickpea. *Journal of Food Legumes*, *23*(3and 4), 226-229.

Singh, M., Mishra, J. S., & Bhatt, B. P. (2017). Effect of integrated nutrient management on production potential and quality of summer mungbean (*Vigna radiata* L.). *Journal of Krishi Vigyan*, *5*(2), 39-45.

Singh, R., Singh, P., Singh, V., & Yadav, R. A. (2018). Effect of phosphorus and PSB on yield attributes, quality and economics of summer Mungbean (*Vigna radiata* L.). *Journal of pharmacognosy and phytochemistry*, *7*(2), 404-408.

Singh, V., Singh, A., Verma, S., Rastogi, M., Yadav, P. K., & Kumar, V. (2022). Evaluation of Different Microbial Inoculum on Mungbean (*Vigna radiata* L.) Growth, Development and Nutrient Availability. *International Journal of Plant & Soil Science*, *34*(20), 295-301. https://doi.org/10.9734/ijpss/2022/v34i2031155.

Tiwari D and Kumar, K. (2009). Effect of biofertilizer and phosphorus levels on growth, nodulation and yield of mungbean (In) international conference on grain legumes, quality improvement value addition and trade held during 14-16 February 2009 at Indian Institute of Pulses Research Kanpur.

Verma, G., Singh, M., Morya, J., & Kumawat, N. (2017). Effect of N, P and biofertilizers on growth attributes and yields of mungbean [*Vigna radiata* (L.) Wilczek] under semi-arid tract of Central India. *International Archive of Applied Sciences and Technology*, *8*(2), 31-34.