Original Paper

Comparison of the Effects of Different Types of Soil Amendments on Mung Bean Yield and Yield Components

Mohammad Khalid Rashidi*[1], Wakil Ahmad Sarhadi[2], Hamid Salari[1], Mohammad Zahid Rashidi[3]

[1]*Kabul University, Agriculture Faculty, Department of Horticulture, Kabul, Afghanistan*
[2]*Kabul University, Agriculture Faculty, Department of Agronomy, Kabul, Afghanistan*
[3]*Wardak Institute of Higher Education, Agriculture Faculty, Department of Horticulture, Wardak, Afghanistan*

Article Details: Received: 2025-01-12 | Accepted: 2025-03-17 | Available online: 2025-06-30

https://doi.org/10.15414/afz.2025.28.02.151-156

Mung bean (*Vigna radiata* L.) is the major source of protein and an important pulse crop in Afghanistan. Low soil fertility in Afghanistan is the main cause of the lower productivity of mung beans. The present investigation was carried out at the agriculture research farm of Kabul University to evaluate the effects of different organic and inorganic soil amendments on yield and yield components of mung beans. The study was conducted during two consecutive years – 2022 and 2023. With various organic and inorganic soil amendments such as farmyard manure, biochar, diammonium phosphate + urea, and urea alone, 120 kg nitrogen·ha^{-1} was applied into the soil. Different crop agronomic traits, including plant height, number of branches per plant, number of leaves per plant, number of pods per plant, grains per pod, and total grain yield, were studied in the experiment. The experiment was conducted in Randomized Complete Block Design (RCBD), and the data were analyzed with Statistical Tools for Agricultural Research (STAR 2.0.1) software. The results indicated that urea improved the mung bean's growth and yield components. The maximum plant height, number of branches per plant, number of leaves per plant, number of pods per plant, grains per pod, and total grain yield were recorded under the urea treatment. For increased productivity of mung beans, the farmers are recommended to apply a proper dose of urea fertilizer.

Keywords: mung bean, biochar, farmyard manure, urea, yield

1 Introduction

The mung bean (*Vigna radiata* L.), often known as green gram, is a pulse crop and a member of the Fabaceae family (Manjunatha et al., 2023). Mung beans are one of the most important summer-grown, short-season legumes and are widely grown in tropical and subtropical areas (Geetika et al., 2022). It ranks as one of Afghanistan's most important pulse crops, after cereal crops including wheat, rice, and maize (Noorzai and Choudhary, 2017; Jalali and Choudhary, 2018). This crop may be utilized for both seeds and feed because of its high biomass and productivity (Kumar and Yadav, 2018).

Mung beans are usually cultivated in warm climates in Afghanistan, such as Kunduz, Helmand, Kandahar, Nangarhar, Parwan, Laghman, Takhar, and Kapisa provinces. Afghanistan is an agricultural country with a growing population with the demand for higher food production. Mung bean contain 51% of carbohydrates, 26% of proteins, 10% of moisture, and 4% of minerals Khyber et al., 2017). Mung bean sprouts are a great source of vitamins and amino acids (Hussain et al., 2011; Saket et al., 2018). Crop residue of food and feed crops has a manure value (Khyber et al., 2017).

Among the Asian nations where it is widely grown are India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, Indonesia, Malaysia, South China, and Argentina (Choudhary et al., 2015). Currently, China, India, Pakistan, and Thailand are the leading producers of mung beans, accounting for almost 90% of global production. In Central and South Asia, mung beans can be used in cropping systems to increase the sustainability of dryland agricultural systems. Intensification of agriculture has become a significant

***Corresponding Author:** Mohammad Khalid Rashidi, Kabul University, Agriculture Faculty, Horticulture Department, Jamal Mina, Kabul City, Kabul, Afghanistan, khalid.rashidi2010@gmail.com

challenge due to increased soil degradation over the last few decades. Mung beans are chosen because they are abundant in nutrients and can also improve soil fertility through the atmosphere nitrogen fixation.

This warm-season crop requires 90–120 days without frost from seed to maturity (Alemayehu, 2022; Degefa et al., 2021). The Watani genotype was superior to Zirati and produced a higher yield when 60 kg P_2O_5·ha^{-1} was applied to soil (Khaleeq et al., 2023).

Land degradation, depletion of SOM, decline in soil fertility, and reduction in the use of organic amendments represent emerging threat to soil health in the western Terai of Nepal. This study investigated the impact of farmyard manure (FYM) and biochar on soil health and mungbean (*Vigna radiata*) yield (Dhungana, 2024).

Thus, future use of organic amendments to supply nutrients to plants and improve crop yields and overall soil health for smallholder and resource-limited farmers should be a central component in their nutrient management plans (Adeg-bite et al., 2021; Diatta et al., 2020; Massah & Azadegan,2016).

Manure is rich in plant nutrients such as N, phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) and is usually applied to soils as a fertilizer for agricultural production in many regions, including semi-arid areas of Africa (Lal, 2006; Sileshi et al., 2017; Zhongqi et al., 2016). Manure application has been demonstrated to account for 15% of the N inputs to cropland (Liu et al.,2010).

Nitrogen is one of the essential macronutrients for crops, and its efficient management can provide higher yields, better crop quality, and higher income for farmers (Fazil et al., 2022). According to the law of minimum, it is always the factor that is in minimum that dictates the crop health and development. Phosphorus is essential to the physiological functions of all plants and responsible for nodulation, root growth, nutrient uptake and can increase the production of pulses (Dass et al., 1997; Balai et al., 2017). Phosphorus deficiency has been suggested as a potential reason for the low legume yield issue (Nazir et al., 2022).

Food security and the nation's need to maintain the rice-wheat cropping system may be met by applying organic fertilizer and manures and by enriching crop rotations with pulse-based crops (Meena et al., 2020). The application of biochar (25 t·ha^{-1}) together with FYM (10 t·ha^{-1}) and mineral nitrogen (30 kg·ha^{-1}) can increase mungbean productivity (Khan, Khyber et al., 2017). Mung bean grain yield is declining as water-stressed areas of the world quickly grow (Eakramul Haque et al., 2023). Mung beans can fix from 63 to 342 kg nitrogen·ha^{-1} (Sadaf and Tahir, 2017; Kaisher et al., 2010).

This study compares the effects of different soil amendments on the growth and yield of mung beans and aims to find and introduce the best fertilizer for maximizing crop yield.

2 Material and Methods

The trials were conducted at the agriculture research farm of Kabul University, Kabul, Afghanistan, from June to August 2022 and 2023. Mung bean seedlings appeared 5–6 days after sowing (DAS). Plant population in each treatment plot was maintained, and gap-filling was completed in two weeks.

Kabul has hot and dry summers and cold, snowy, or partly overcast winters. Throughout the year, the average temperature fluctuates between -4.44 °C and 33.8 °C; it is rarely lower than -10 °C or higher than 37.2 °C.

The topsoil (0–30 cm) properties of the study field were tested. The soil was silty clay in texture with the following characteristics: organic matter – 3.04%, P_2O_5 – 45.05 ppm, K – 319 ppm, $CaCO_3$ – 14.8%, EC – 0.24 ms·cm^{-1}, pH – 8.12, and cation exchange capacity – 21.4 meq·100 g^{-1} (Azizi and Sahbani, 2022).

Application of 120 kg of nitrogen·ha^{-1} through farmyard manure, biochar, diammonium phosphate (DAP) + urea, and urea alone were the treatments used in this experiment. The mentioned amount of nitrogen was applied to soil through farmyard manure at the rate of 6 metric t·ha^{-1}, biochar at the rate of 17.3 metric t·ha^{-1}, diammonium phosphate + urea at the rate of 130 and 210 kg·ha^{-1}, respectively, and urea alone at the rate of 261 kg·ha^{-1}. The biochar was sourced from maize residual containing 0.82% nitrogen, 68.91% carbon, 2.72% hydrogen, and 18.6% oxigen. The molar ratios of H/C and O/C of the biochar were 0.47 and 0.20, respectively. Its pH, EC, and CEC were 9.35, 167.7 mS·m^{-1}, and 18.90 cm·kg^{-1}, respectively. The application of the biochar came before cultivation. Farmyard manure was also administered during the field preparation process, and a half dosage of urea with full di-ammonium phosphate was applied during the final land preparation while another half – 25 days after sowing. The experimental field was 90 square meters and was devided into twelve plots, 7.5 square meters (2.5 by 3 m). The randomized complete block design (RCBD) experiment used four treatments in three replications. Plants were spaced 10 cm apart, and rows were separated by 30 cm. The seeds were manually planted in a line at a depth of 3 cm.

Two weedings were performed: 20 and 40 days after sowing. Weeds were also kept out of drainage canals and demarcation lines. Every seven days, the plots were irrigated using the flood irrigation method. Data of the growth and yield parameters were collected from at least ten plants in each plot. The pods were picked up twice because of their non-synchronous maturity. The first round of pod picking was completed at 80 DAS, while the second – at 90 DAS.

Plant height was measured in cm, and the number of branches·plant^{-1}, leaves·plant^{-1}, pods·plant^{-1}, and grains·pod^{-1} were manually counted. Total grain yield was recorded in kg·plot^{-1} and presented in metric t·ha^{-1}. The total biomass yield (grain + straw) represented the biological yield.

At the 5% significance level, the *F*-test and coefficient of variance values were computed for the significant displayed parameters. ANOVA and the least significant difference (LSD) were used to represent the results of the data analysis, which was conducted using the Statistical Tools for Agricultural Research (STAR 2.0.1).

3 Results and Discussion

3.1 Growth Parameters

The data on plant height, number of branches· plant^{-1}, and number of leaves·plant^{-1} is presented in Table 1. The application of various soil amendments significantly affected the studied growth parameters. The highest plants were growing under urea treatment (the average plant height – 30.1 cm), while the lowest under biochar treatment (the average plant height – 23.2 cm). The similar results were also found for the average number of branches·plant^{-1}: under urea treatment it was the highest (4.87) while under biochar treatment – the lowest (2.9). Urea application also resulted in the highest average leaf number·plant^{-1} (18.6), compared to the biochar treatment which resulted in the significantly lowest leaf number·plant^{-1} (14.4). At the same time these parameters under FYM, Biochar, and DAP + urea treatments did not differ significantly.

In agreement with this finding (Haque et al., 2023) showed that the application of prilled urea in furrows promoted the mung bean crop's growth-related parameters, including the highest plant height (50.57 cm), the maximum number of leaves·plant^{-1} (22.57), the maximum number of branches·plant^{-1} (6.00), and the highest above-ground dry matter·plant^{-1} (12.08 g), which could improve yield in comparison to all other treatments examined. However, regarding mung bean yield contributing characteristics, the application of urea super granules (USG) at a distance of 40 cm and a depth of 10 cm showed the worst growth responses. Anwar et al. (2018) also reported that nitrogen application at a rate of 30 kg·ha^{-1} produced the maximum number of branches·plant^{-1}. Khan, Hussain et al. (2017) also reported that applying nitrogen at a rate of 30 kg·ha^{-1} resulted in the highest number of branches·plant^{-1}. Similar findings regarding vigorous growth of mung beans under urea application were reported by Khan, Khyber et al. (2017). In contrast, poor plant growth was reported under reduced nitrogen application at the rate of 15 kg·ha^{-1} (Khan, Khyber et al., 2017). The findings of Fazil et al. (2024) indicated that 20 kg nitrogen·ha^{-1} and 40 kg P_2O_5·ha^{-1}, both in combination and independently, greatly improved the growth parameters (plant height, and number of branches·plant^{-1}).

3.2 Yield Parameters

According to statistical analysis, the studied treatments differed significantly (P <0.05) in the average number of pods·plant^{-1}, number of grains·pod^{-1}, and grain yield (Table 2). The Urea treatment resulted in the highest number of pods·plant^{-1} (9.57), while the Biochar treatment had the lowest number of pods·plant^{-1} (4.93). The highest number of grains·pod^{-1} was found in the DAP + urea treatment, which did not differ significantly from

Table 1 Mung bean plant parameters under different treatments

Treatments	Plant height (cm)	Number of branches (pcs·plant^{-1})	Number of leaves (pcs·plant^{-1})
FYM	24.67^{b}	3.4^{bc}	15.3^{b}
Biochar	23.2^{b}	2.9^{c}	14.4^{b}
DAP + urea	23.7^{b}	3.7^{b}	16.2^{ab}
Urea	30.1^{a}	4.87^{a}	18.6^{a}
F-test	*	*	*
LSD (0.05)	4.98	0.76	2.54
CV (%)	9.81	10.33	7.89

CV (%) – coefficient of variation; LSD – least significant difference, * significant level at (P <0.05); different letters indicate the groups with significant differences

Table 2 Mung bean yield parameters under different treatments

Treatments	Number of pods·plant^{-1}	Number of grains·pod^{-1}	Grain yield (kg·ha^{-1})
FYM	7.43^{ab}	9.67^{ab}	714.2^{ab}
Biochar	4.93^{b}	8.83^{b}	476.1^{b}
DAP + urea	8.20^{a}	10.6^{a}	952.3^{a}
Urea	9.57^{a}	9.9^{ab}	857.1^{a}
F-value	*	*	*
LSD (0.05)	2.5335	1.1119	256.16
CV (%)	16.83	5.71	17.10

CV (%) – coefficient of variation; LSD – least significant difference; * significant level at (P <0.05); different letters indicate the groups with significant differences

the urea and FYM treatments, whereas the lowest number of grains·pod^{-1} was measured in the biochar treatment. The DAP + urea and urea treatments resulted in the highest yield, while the biochar treatment – in the lowest. The highest biological yield was recorded in urea treatment, and the lowest – in biochar treatment.

Consistent with this study (Khan, Hussain et al., 2017) noticed that applying biochar does not improve the seed yield and biological yield of mung beans, while the higher dose of nitrogen increased both yield and yield components of mung beans. According to the study results of Dhungana (2024), while FYM and biochar can help improve soil fertility and fight soil degradation in the Terai region, their impacts on mung bean productivity in this setting were not statistically significant. Meena et al. (2020) study found that pressmud at 3 t·ha^{-1} improved pod length, the number of pods, seeds·pod^{-1}, test weight, grain yield, straw yield, biological yield, harvest index, protein content, and protein yield. Moreover, the lowest parameters were recorded in the biochar treatment of 3 t·ha^{-1}. Also (Danish et al., 2022) documented the same outcome for bed planting maize + mung bean, with nitrogen applied at a rate of 120 kg·ha^{-1} to increase maize grain yield. At this N rate maize had the highest grain yield (3.17 t·ha^{-1}). Ton (2024) reported that KPS1 genotype of mung bean obtained the maximum seed yield at 80 kg nitrogen·ha^{-1}. Anwar et al. (2018) also reported that nitrogen application at a rate of 30 kg·ha^{-1} produced the maximum pods·plant^{-1}, seeds·pod^{-1}, biological yield, and grain yield. Khan, Hussain et al. (2017) reported analogous findings, indicating that applying nitrogen at a rate of 30 kg·ha^{-1}

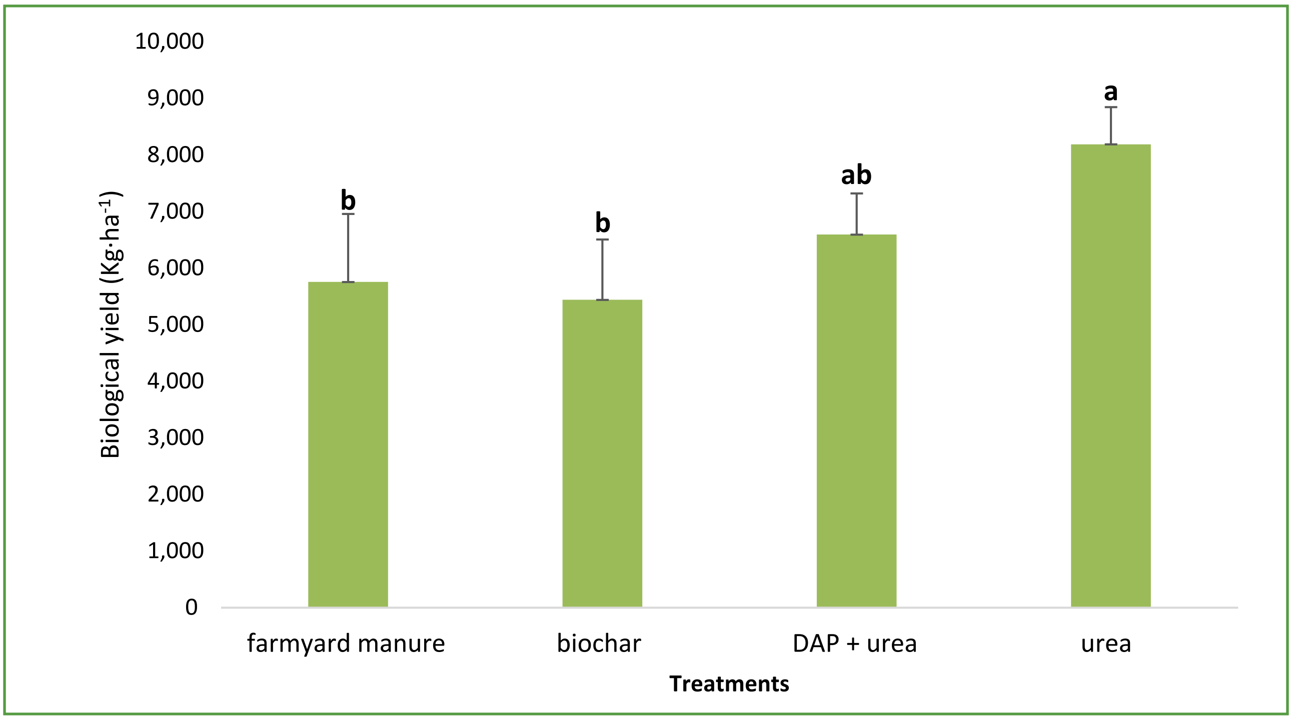

Figure 1 Mung bean biological yield under different treatments

resulted in the highest number of pods·plant^{-1}, number of seeds·pod^{-1}, biological yield, and grain yield.

The biological yield of mung beans was significantly (P <0.05) higher in the urea treatment compared to the Biochar and FYM treatments, which produced the lowest biological yields (Figure 1). The findings of Fazil et al. (2024) indicated that 20 kg nitrogen·ha^{-1} and 40 kg P_2O_5·ha^{-1}, both in combination and independently, greatly improved total yield.

4 Conclusion

The results of this investigation suggest that organic sources of nitrogen, including biochar and farmyard manure, are slow-releasing in nature. In contrast, inorganic sources like urea and DAP are fast-releasing nitrogen sources, improving nitrogen availability to crops and increasing crop growth and yield. Although organic soil amendments, including biochar and farmyard manure, improve soil properties, to obtain vigorous plants and a higher yield of mung beans, the nitrogen from an inorganic source (urea) shall be applied to the soil.

Acknowledgments

The authors are grateful to Kabul University for their technical support.

References

Adegbite, E. A., Atere, C. T., & Olayinka, A. (2021). Growth, nitrogen fixation and yields of cowpea (*Vigna unguiculata* L. Walp) and chemical properties of an acid Alfisol in response to applications of organic amendments and inorganic N. *Journal of Plant Nutrition*, 44(5), 692–703. https://doi.org/10.1080/01904167.2020.1849291

Alemayehu, S. (2022). Adaptation studies of mung bean (*Vigna radiata* L.) Varieties under irrigated condition in the middle Awash Rift Valley of Ethiopia: the case of werer station. *Forestry and Fisheries*, 11(6), 220–225. https://www.researchgate.net/publication/368281702

Anwar, S., Saeed, B., Islam, M., Owais Khan, M., & Ahmad, J. (2018). Response of mung bean to organic sources and nitrogen levels. *Pure Appl. Biol.*, 7(2), 692–699. https://www.cabidigitallibrary.org/doi/full/10.5555/20183379536

Balai, R.C., Meena, L.R. & Sharma, S.C. 2017. Effect of different levels of nitrogen and phosphorus on cowpea [*Vigna unguiculata* (L.) Walp] under rainfed conditions of Rajasthan. *Journal of Agriculture and Ecology*, 3, 19–24. http://doi.org/10.53911/JAE.2017.3103

Choudhary, A. K., Rana, D. S., Bana, R. S., Pooniya, V., Dass, A., Kaur, R., & Rana, K. S. (2015). *Agronomy of oilseed and pulse crops*. Post Graduate School, IARI, ICAR, DARE (218 p.).

Danish, M., Kumar, M., Pramanick, B., Singh, S. K., & Hashim, M. (2022). Enhancing crop productivity, water, and nitrogen use efficiency of kharif maize through planting methods, mungbean intercropping and nitrogen management practices. *Journal of Cereal Research*, 14(1). http://doi.org/10.25174/2582-2675/2022/123995

Dass A, Kharwara PC & Rana SS. 1997. Response of gram varieties to sowing dates and phosphorus level under on-farm conditions. *Himachal Journal of Agricultural Research*, 23(1&2), 112–115. https://www.cabidigitallibrary.org/doi/full/10.5555/19990706976

Degefa, G., Ahmad, A., & Belete, K. (2021). Effect of row spacing and phosphorus fertilizer rates on yield and yield related traits of mung bean (*Vigna radiata* l.) at Fedis, Eastern Ethiopia. *Journal of Plant Sciences*, 9(2), 65. https://doi.org/10.11648/j.jps.20210902.15

Dhungana, B. (2024). *Effect of fym and biochar with residual nutrients on soil health and mungbean yield in rupandehi, Nepal*. thesis. https://doi.org/10.13140/RG.2.2.34688.85761

Diatta, A. A., Fike, J. H., Battaglia, M. L., Galbraith, J. M., & Baig, M.B. (2020). Effects of biochar on soil fertility and crop productivity in arid regions: A review. *Arabian Journal of Geosciences*, 13(14), 595. https://doi.org/10.1007/s12517-020-05586-2

Eakramul Haque, M., Rha, S., Abdul Karim, M., Ahammad Siddiqui, S., Mahmud, A., Abdul Khaliq, Q., Moynul Haque, M., & M Solaiman, A. R. (2023). Growth and yield variations in mung bean varieties under water stress. *Ecology Journal*, 5 (1), 37–47. https://www.researchgate.net/profile/Apple-Mahmud-2/publication/373490024

Fazil, K., Das, T.K., Nath, C.P., Nazir, R., & Samim, M. (2022). Nitrogen and weed management effects on weeds and barley yield in Kandahar, Afghanistan. *Indian Journal of Weed Science*, 54(3), 309–313. https://www.isws.org.in/IJWSn/Full_PDF/54(3)_2022.pdf

Fazil, K., Hayat, S. H., Obaid, H., Ashna, A. Z., & Nimgarri, H. (2024). Effect of nitrogen and phosphorus on growth and yield of mungbean. *Journal of Agriculture and Ecology*, 18, 44–47. https://doi.org/10.58628/JAE-2418-107

Geetika, G., Collins, M., Singh, V., Hammer, G., Mellor, V., Smith, M., & Rachaputi, R. C. N. (2022). Canopy and reproductive development in mungbean (*Vigna radiata*). *Crop and Pasture Science*, 73(10), 1142–1155. https://doi.org/10.1071/CP21209

Haque, M. M., Islam, M. A., Amin, A. K. M. R., & Karim, M. F. (2023). Mung bean (*Vigna radiata* L.) growth response to prilled and super granule urea application. *Journal of Bioscience and Agriculture Research*, 31(01), 2581–2588. https://doi.org/10.18801/jbar.310123.311

Hussain, F., Malik, A.U., Haji, M.A., & Malghani, A.L. (2011). Growth and yield response of two cultivars of Mung bean (*Vigna radiata* L.) to different potassium levels. *Journal of Animal & Plant Sciences*, 21(3), 622–625. https://www.researchgate.net/profile/Asmat-Ullah-3/publication/267790569

Kaisher, M.S., Rahman, M.A., Amin, M.H.A., Amanullah, A.S.M., & Ahsanullah, A.S.M. 2010. Effects of sulfur and boron on the seed yield and protein content of Mung bean. *Bangladesh Research Publication Journal*, 3, 1181–1186.

Khaleeq, K., Amini, A. M., Behzad, M. A., Hemmat, N., Rathore, S. S., & Mansoor, M. A. (2023). Productivity of Mung bean (*Vigna radiata*) as influenced by phosphorus fertilizer. *Journal of Agriculture and Ecology*, 17, 71–74. https://doi.org/10.58628/JAE-2317-312

Khan, N., Hussain, Z., Ullah, S., Liaqat, A., Nawaz, F., Ur, A., Khalil, R., Shah, A., Junaid, M., Ali, M., & Pakistan, P. (2017). Response of mungbean to various levels of biochar, farmyard manure and nitrogen. *World Journal of Agricultural Sciences*, 13(1), 26–33. https://www.researchgate.net/profile/Nangial-Khan-2/publication/331562825

Kumar, S., & Yadav, S. S. (2018). Effect of Phosphorus Fertilization and Bio-organics on Growth, Yield and Nutrient Content of Mung bean (*Vigna radiata* (L.)Wilczek)]. *Research Journal of Agricultural Sciences*, 9(6), 1252–1257. https://www.researchgate.net/publication/330737406

Lal, R. (2006). Enhancing crop yields in the developing countries through restoration of the soil organic carbon pool in agricultural lands. *Land Degradation & Development*, 17(2), 197–209. https://doi.org/10.1002/ldr.696

Liu, J., You, L., Amini, M., Obersteiner, M., Herrero, M., Zehnder, A.J. B., & Yang, H. (2010). A high-resolution assessment on global nitrogen flows in cropland. *Proceedings of the National Academy of Sciences*, 107(17), 8035–8040. https://www.pnas.org/doi/pdf/10.1073/pnas.0913658107

Manjunatha, P. B., Harisha, R., Kohli, M., Naik, P. K., Sagar S. P., Shashidhar B. R., Patel, M. K., Ganesh, B. T., Madhusudhan B. S., Chethan Kumar K. B., Kumar, S., Ragi, S., Patil, S., & Manoj Gowda M. (2023). Exploring the world of mungbean: uncovering its origins, taxonomy, genetic resources and research approaches. *International Journal of Plant & Soil Science*, 35(20), 614–635. https://doi.org/10.9734/ijpss/2023/v35i203846

Massah, J., & Azadegan, B. (2016). Effect of chemical fertilizers onsoil compaction and degradation. *Agricultural Mechanization in Asia, Africa and Latin America*, 47(1), 44–50. https://www.savegroundwater.org/wp-content/uploads/2023/10/Soil-compaction-fertilizer-permeability.pdf

Meena, R. S., Verma, T., Verma, S. K., Singh, A., Kumar, S., & Gurjar, D. S. (2020). Influence of organic and inorganic sources of nutrients on growth, yield, and quality of Mung bean (*Vigna radiata*). *Indian Journal of Agricultural Sciences*, 90(11), 2233–2236. https://doi.org/10.56093/ijas.v90i11.108601

Naim Jalali, M., & Choudhary, A. K. (2018). Influence of varying nitrogen levels on productivity, resource-use efficiency, and profitability of summer mungbean (*Vigna radiata* L. wilczek) in Kandahar province of Afghanistan. *Ann. Agric. Res. New Series,* 39 (2). https://www.researchgate.net/profile/Anil-Choudhary-6/publication/323393057

Nazir, R., Ahmad Sayedi, S., Zaryal, K., Khaleeq, K., Godara, S., Bamboriya, S. D., & Bana, R. (2022). Effects of phosphorus application on bunch and spreading genotypes of groundnut. *Journal of Agriculture and Ecology*, 14. https://doi.org/10.58628/JAE-2214-24

Noorzai, A. U. & Choudhary, A. K. (2017). Influence of summer mungbean genotypes on grain yield and resource-use efficiency in Kandahar province of Afghanistan. *Ann. Agric. Res. New Series,* 38(2). https://epubs.icar.org.in/index.php/AAR/article/view/75049

Sadaf, A. and M. Tahir. 2017. Effect of potassium on growth, yield, and quality of mung bean under different irrigation regimes. *Bulletin of Biological and Allied Sciences Research*, 2(4), 1–10. https://bbasr.org/index.php/home/article/view/10

Sahbani, M., Hamidi, E., & Shams, S. (2023). Land Suitability Evaluation Using Parametric Approach to Achieve Sustainable Development. *Alumfuns*, 62. https://www.researchgate.net/publication/389517312

Sileshi, G. W., Nhamo, N., Mafongoya, P. L., & Tanimu, J. (2017). Stoi-chiometry of animal manure and implications for nutrient cycling andagriculture in sub-Saharan Africa. *Nutrient Cycling in Agroecosys-tems*, 107(1), 91–105. https://link.springer.com/article/10.1007/s10705-016-9817-7

Ton, A. (2024). Influence of different nitrogen levels on the morpho-agronomic and quality traits of some mung bean [*Vigna radiata* (l.) Wilczek] genotypes. *Pakistan Journal of Botany*, 56(1), 315–322. https://doi.org/10.30848/PJB2024-1(29)

Zhongqi, H., Pagliari, P. H., & Waldrip, H. M. (2016). Applied andenvironmental chemistry of animal manure: A review. *Pedosphere*, 26(6), 779–816. https://www.researchgate.net/profile/Heidi-Waldrip-2/publication/309660882