International Journal of Plant & Soil Science

Volume 37, Issue 6, Page 342-348, 2025; Article no.IJPSS.136843
ISSN: 2320-7035

Acid Soil Management for Improvement of Yield and Soil Nutrient in Black gram (*Vigna mungo L.*) Cultivation in Dibrugarh District of Assam, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2025/v37i65514

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/136843

Original Research Article

Received: 03/04/2025
Accepted: 06/06/2025
Published: 12/06/2025

ABSTRACT

Black gram is widely grown in Dibrugarh district of Assam. However, existing soil acidic condition limits nutrient uptake and profitable production of the crop. An experiment was conducted during *kharif* season (September - November) of 2024 at farmers field' in Dibrugarh district of Assam,

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Cite as: *Tamuli, Babita, Hemchandra Saikia, Rupjyoti Borah, Sanghomita Sarma, Shantonu Paul, Chayanika Thakuria, and Sharmistha Borgohian. 2025. "Acid Soil Management for Improvement of Yield and Soil Nutrient in Black Gram (Vigna Mungo L.) Cultivation in Dibrugarh District of Assam, India". International Journal of Plant & Soil Science 37 (6):342-48. https://doi.org/10.9734/ijpss/2025/v37i65514.*

India to manage soil acidity by application of lime amendment for yield improvement of black gram (*Vigna mungo L.*). The experiment was consisted of three treatments T_1: Lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + Recommended dose of fertilizer (15: 35: 15 kg ha^{-1}), T_2: Recommended dose of fertilizer (15:35:15 kg ha^{-1}) and T_3: Control: Farmers' practice (manure 1 t ha^{-1}). The On-Farm Trials were conducted in randomized complete block design. The results revealed that application of lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + Recommended dose of fertilizer (15: 35: 15 kg ha^{-1}) recorded significantly higher yield followed by only recommended dose of fertilizer (15:35:15 kg ha^{-1}) and farmers' practice. The yield increased significantly with application of lime combined with recommended doses of fertilizer (1395 kg ha^{-1}) compared to the farmers practice (85 kg ha^{-1}). With regard to economics, the benefit-cost ratio of Lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + Recommended dose of fertilizer treatment recorded the highest (2.15). Soil pH increased significantly in the treatment receiving lime 489 kg ha^{-1} compared with the sole application of recommended dose of fertilizer and control. The available phosphorus (kg ha^{-1}) showed similar trend and highest value was observed as 35.70. Therefore, lime application with recommended doses of fertilizer could enhance the yield of black gram and available nutrient status of soil.

Keywords: Farm trial; lime; black gram; yield; soil nutrients.

1. INTRODUCTION

"Black gram, is one of the important grown pulse crops in India. It is the cheapest source of food protein thereby considered as the poor men's meat. Currently, India represents the largest producer of Black gram accounting for more than 70% of the global production. India produces approximately 2 million tons of black gram with an average yield of 598 kg ha^{-1} during 2023–24" (Anonymous, 2023-24). "Madhya Pradesh, Uttar Pradesh, Rajasthan, Karnataka and Andhra Pradesh are the major producer states of black gram in India during kharif season. North Eastern regions (NER) of India represent less than 5% in pulse production. During 2020-21, Assam produces 0.37 lakh tonnes of black gram from an area of 0.56 lakh ha with a productivity of 651 kg ha^{-1}" (Anonymous, 2021).

"Black gram (**(***Vigna mungo L.*) is one of the most potential leguminous field crops for crop diversification and enhancing the productivity of rice-based cropping systems in NER. Pulses are soil-building crops capable of transforming the dominant cereal-based cropping systems to an ideal and sustainable system in time to come" (Praharaj et al., 2017). Being a legume and a drought resistant crop, black gram fixes atmospheric nitrogen which enriches the soil and also exhibits great resilient to long period of water scarcity (Jamir et al., 2024). However, the productivity of the crop is low in this region and soil acidity is one of the major factors. Heavy rainfall received in the region leads to soil acidity which further aggravates the low agricultural productivity (Majumdar et al., 2022).

"Soil acidity is a critical abiotic stress that negatively affects crop growth and yield. More than 21 million ha of acid soils are found in North Eastern Regions of India, whereas, 4.68 millon ha area is affected by soil acidity in Assam" (Majumdar et al., 2022). "Acidity– induced soil fertility problems along with traditionally minimal use of mineral fertilizers are often responsible for low levels of crop productivity in the state. Severe deficiencies of phosphorus, calcium, magnesium, molybdenum and toxicities of aluminium and iron in the acidic soils limits crop production in this region" (Swami and Yadav, 2020). "Poor plant vigour, uneven crop growth, poor nodulation of legumes, stunted root growth, persistence of acid-tolerant weeds, increased incidence of diseases and abnormal leaf colours are major symptoms of increased soil acidity which may lead to reduced yields of the crop" (Marschner, 2011). "Proper management practices of soil acidity are therefore imperative for improving food security globally and regionally. Lime is the major means of ameliorating soil acidity because of its very strong acid neutralizing capacities, which can effectively remove existing acid, stimulate biological activity and reduce toxicity of heavy metals" (Ameyu, 2019). "The most efficient crop production on acid soils is the application of both lime and fertilizer. Several studies have reported lime application as a strategy for increasing soil pH and one of the most inexpensive practices for managing soil acidity" (Orton et al., 2018). "Liming can increase soil pH, availability of essential plant nutrients, crop yields and prevent solubility of manganese and aluminium" (Holland et al., 2018; Holland et al., 2019). "Many

research on application of lime reports that agricultural practices plays a significant role in the effectiveness of liming. Agricultural management practices relevant to liming are sources of lime materials, rate of application, method, and frequency of application" (Anderson et al., 2013). However, despite the proven benefit of liming, in terms of raising soil pH and correcting the acidity induced abiotic constraints in soil, the practice is not very popular among the farming community. In the premise of the above background, an On Farm Trial (OFT) was conducted at the farmers' field to manage soil acidity by application of lime amendment for yield improvement of black gram.

2. MATERIALS AND METHODS

The experiment was conducted during *kharif* season (September- November) of 2024 at three farmers' field covering 0.6 ha of land at Dibrugarh District of Assam, India located in between latitude 27°50′ to 27°42′N and longitude 94°33′ to 95°29′E. The area under each trial was 0.2 ha. The climate of Dibrugarh is Subtropical, with pleasantly warm, dry winters from November to February and a long, hot and rainy period from April to mid-October. The average Temperature of Dibrugarh is around 23°C although it varies from around 17°C during Winter (January) to 28°C during the Monsoon (August). Precipitation amounts to 2610 mm, with a maximum rainfall of 525 mm recorded in July, with a relative humidity of 75% (District Survey report, Dibrugarh, 2024). The soil type of the district is sandy to clayey loam with pH 5.5, organic carbon, 0.95%, available N, P and K status 347.76, 31.90 and 268.80 kg ha^{-1}, respectively. The treatments of the trial were T_1: Lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + Recommended dose of fertilizer (15: 35: 15 kg ha^{-1} NPK), T_2: Recommended dose of fertilizer (15:35:15 kg ha^{-1}) and T_3: Control: Farmers' practice (manure 1 t ha^{-1}). The On-Farm Trials were conducted in randomized complete block design. The recommended dose of nitrogen, phosphorus and potassium (15 kg N, 35 kg P and 15 kg K_2O ha^{-1}) were applied through urea, single super phosphate and muriate of potash, respectively. The black gram variety taken was SBC 40. The crop was sown on 9th to 10th September, 2024. Spacing of 30x10 cm^2 was followed with a seed rate of 22.5 kg ha^{-1} for sowing of black gram. Harvesting was done at 75–85 days after sowing when 75% of the pods mature. The seed yield was expressed at 14% moisture content.

"Soil samples were taken after harvest of the crop and analysed for organic carbon" (Walkley and Black, 1934), available nitrogen by alkaline potassium permanganate method (Subbiah and Asija, 1956), available phosphorus by Bray's I method (Bray and Kurtz, 1945), available potassium by extraction with neutral normal ammonium acetate method (Jackson, 1973). The physical and chemical properties of lime used in the investigation are presented in Table 1. "All the participating farmers were trained on all aspects of black gram cultivation and soil fertility management before implementing the OFTs at their field. All the observations were statistically analyzed by using the statistical methods" described by Panse and Sukhatme (1989).

Table 1. Physical and Chemical properties of lime used in the investigation

Properties	Value
Water absorption	0.62%
Specific gravity (G)	2.68
Lime (CaO)	38-42%
Silica (SiO)	15-18%
Alumina (Al_2O_3)	3-5%
MgO	0.5-3%
FeO+Fe_2O_3	1-1.5%
Alkalies	1-1.5%

3. RESULTS AND DISCUSSION

3.1 Seed Yield

The application of lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + Recommended dose of NPK @15: 35: 15 kg ha^{-1} had given significantly higher yield i.e. 1395 kg ha^{-1} followed by recommended dose of fertilizer (15:35:15 kg ha^{-1}) (1175 kg ha^{-1}) (Table 2). This may be due to improvement of soil pH and other soil nutrients requirement by the crop. This is also similarly reported by Swami and Singh (2020). It appears that liming increased soil pH and availability of nutrients which increased the yield components of black gram and finally higher yields of black gram. Oliver et al. (2021) reported that "the strongest factor that influences yield under acidic soil conditions is the liming rate".

The percentage increase in average yield recorded as 50 and 26.34 in the treated plots over the farmer's practice (Table 2). Kumar et al. (2015) also found the increased yield of black gram by 34.1 to 81.6% over farmer practice by the use of improved variety and balanced application of fertilizers.

Table 2. Effect of lime on yield and economics of black gram

Technology Details	Avg. yield (Kg ha^{-1})	% increase/ change in average yield over local	Gross Cost (Rs ha^{-1})/ (Rs. unit^{-1})	Gross Return (Rs ha^{-1})/ (Rs. unit^{-1})	Net Return (Rs ha^{-1})/ (Rs. unit^{-1})	B:C Ratio (GR/GC)
Lime 489 kg ha^{-1}+2% urea spray at pod initiation stage+RDF (15: 35: 15 kg ha^{-1})	1395	50	22,225	47,778	25,554	2.15
RDF (15:35:15 kg ha^{-1})	1175	26.34	21,900	40,243	18,343	1.83
Control: Farmers' practice (manure 1 t ha^{-1})	85	-	19,700	29,112	9,412	1.47
CD (p=0.05)	0.034					
Significant at 0.05 level (p<0.05)						

Table 3. Effect of lime on available soil nutrient status

Treatments	pH	Organic C (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + RDF (15: 35: 15 kg ha^{-1})	6.05	0.98	387.18	35.70	315.70
RDF (15:35:15 kg ha^{-1})	5.6	0.94	378.32	34.56	310.23
Control: Farmers' practice (manure 1 t ha^{-1})	5.52	0.93	370.83	32.45	295.68
CD (p=0.05)	0.04	0.021	0.015	0.010	0.038

Similar result of increase of black gram yield by 45% over the farmer practice was reported by Bordoloi (2022). “The yield advantage of 36.9 to 192.0% has also been reported in earlier studies” (Kumar et al., 2007 and Choudhary et al., 2006). Satya and Swami (2021) also reported improvement in yield of black gram with soil fertility management in acid Inceptisol of Meghalaya. Similarly liming had positive effects on the yield as reported by Lalljee and Facknath (2001).

3.2 Economics

The Net Return and Benefit Cost ratio were calculated by taking the prevailed cost of commodities during the year of demonstration. The net return (Rs ha^{-1}) is highest in the application of application of Lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + recommended dose of NPK @15: 35: 15 kg ha^{-1}, *viz*. Rs. 25,554 /- (Table 2). “This is also recorded that the application of treatment had given significantly higher B.C ratio of 2.15 followed by recommended dose of fertilizer (15:35:15 kg ha^{-1}) (B: C ratio 1.83) farmers practice (B.C ratio 1.44). This may be due to higher yields obtained under recommended practices compared to farmers’ practice. Similar results of improved benefit-cost ratio were observed” by Kumar et al. (2007) by the application of improved soil fertility management in black gram crop.

3.3 Available Soil Nutrient Status

Soil samples were collected before the implementation of the technology and at the time of harvesting. The available nutrient status was significantly increased with the application of Lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + recommended dose of NPK @15: 35: 15 kg ha^{-1} from initial to final stage of the crop (Table 3). The finding reveals that the soil was acidic in nature with high organic carbon content. The organic carbon, available nitrogen, available phosphorus and available potassium status of soil after harvest of the crop increased due to application of lime. Oliver et al. (2021) reported that “the important factor that influences yield and pH changes under acidic soil conditions is the rate of liming and it was inferred that a higher liming rate will solve issues relating to subsoil acidity”. “However, the magnitude of the increase in soil pH might differ depending on management practice” (Enesi et al., 2023).

“The application of lime along with the fertilizer significantly increased soil organic carbon (0.98%) could be attributed that application of lime improved soil environment resulting in higher root biomass, crop residues and stubbles of the crop” (Meena et al., 2017). “Liming increases the beneficial microbial activity of the soil with increase in pH of acidic soil thus enhancing the net mineralization of organic N which in turn led to enhance the soil nitrogen availability” (Edmeades and Ridley, 2003). Lime application increased the soil pH which helped the release of fixed P from the oxides and hydroxides of Fe and Al thus increased the P availability in soils (Table 3). The ultimate effects of reasonable application of lime are generally considered to promote soil K availability as well as the efficiency of K fertilizer on acid soils (Arenjungla et al., 2021).

4. CONCLUSION

Soil acidity decreases the availability of most of the plant nutrients and also affects the yield of black gram. From the study, it can be concluded that application of lime 489 kg ha^{-1}+2% urea spray at pod initiation stage + recommended dose of NPK @15: 35: 15 kg ha^{-1} was found effective for getting optimum production of black gram and sustainability of soil health in acid soil of Dibrugarh, Assam. The findings of the study may be significant use for the farmers of Dibrugarh, Assam as they can include lime as a component of soil management along with recommended dose of fertilizer in black gram cultivation and can boost- up production in acidic soil while managing soil acidity in a better way, thereby ensuring long term sustainability of soil health.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript**.**

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Ameyu, T. (2019). A review on the potential effect of lime on soil properties and crop

productivity improvements. *Journal of Environment and Earth Science, 9*(2), 17–23.

Anderson, N. P., Hart, J. M., Sullivan, D. M., Horneck, D. A., & Pirelli, G. J. (2013). *Applying lime to raise soil pH for crop production (Western Oregon)* (EM 9057). Corvallis, OR: Oregon State University Extension.

Anonymous. (2021). *Crop-wise area, production and productivity of pulses from 2010–11 to 2020–21*. Retrieved December 20, 2024, from https://dpd.gov.in

Anonymous. (2023–24). *ANGRAU Black gram outlook report, Centre for Agriculture and Rural development Policy research (CARP). Crop outlook reports of Andhra Pradesh Black gram – June to May* (pp. 1–6).
Retrieved January 5, 2025, from https://angrau.ac.in

Arenjungla, Ao., Lowrence, K., & Tongpang Longkumer, L. (2021). Effect of lime and integrated nutrient management on rice-pea cropping system. *International Journal of Bio-resource and Stress Management, 12*(3), 228–237.

Bordoloi, P. (2022). Lime application for higher productivity of potato (*Solanum tuberosum* L.) and managing soil acidity in Ri-Bhoi District of Meghalaya. *Indian Research Journal of Extension Education, 21*(2&3), 150–153.

Bordoloi, P. (2022). Productivity enhancement of black gram (*Vigna mungo* L.) as influenced by lime in acid inceptisol and yield gaps analysis in Ri-Bhoi district of Meghalaya. *Pharma Innovation Journal, 11*, 2565–2569.

Bray, R. H., & Kurtz, L. T. (1945). Determination of total, organic and available form of phosphorus in soils. *Soil Science, 59*, 39–45.

Choudhary, A. K., Thakur, R. C., & Kumar, N. (2006). Effect of integrated nutrient management on water use and water-use-efficiency in wheat-rice crop sequence in N-W. *Indian Journal of Soil Conservation, 34*(3), 233–236.

District Survey Report, Dibrugarh, Assam. (2024). *Ministry of Environment, Forest and Climate Change* (pp. 1–102).

Edmeades, D. C., & Ridley, A. M. (2003). Using lime to ameliorate topsoil and subsoil acidity. In Z. Rengel (Ed.), *Handbook of soil acidity* (pp. 297–336). New York: Marcel Dekker.

Enesi, R. O., Dyck, M., Chang, S., Thilakarathna, M. S., Fan, X., Strelkov, S., & Gorim, L. Y. (2023). Liming remediates soil acidity and improves crop yield and profitability – a meta-analysis. *Frontiers in Agronomy, 5*, 1194896.

Holland, J. E., Bennett, A. E., Newton, A. C., White, P. J., McKenzie, B. M., & George, T. S. (2018). Liming impacts on soils, crops and biodiversity in the UK: A review. *Science of the Total Environment, 610–611*, 316–332.

Holland, J. E., White, P. J., Glendining, M. J., Goulding, K. W. T., & McGrath, S. P. (2019). Yield responses of arable crops to liming – An evaluation of relationships between yields and soil pH from a long-term liming experiment. *European Journal of Agronomy, 105*, 176–188.

Jackson, M. L. (1973). *Soil chemical analysis*. New Delhi: Prentice Hall of India Private Limited.

Jamir, T. I., Sharma, Y. K., & Uchoi, A. (2024). Nutrient composition, uptake, yield and phosphorus use efficiency of black gram as influenced by soil amendments and phosphorus in acidic soil of Nagaland. *Agricultural Science Digest*, 1–7.

Kumar, S., Choubey, A. K., & Singh, R. (2015). Analysis of yield gaps in black gram (*Vigna mungo*) in district Bilaspur of Himachal Pradesh. *Himachal Journal of Agricultural Research, 41*(1), 49–54.

Kumar, V., Kumar, A., Kumar, A., & Bhateria, S. (2007). Demonstration – An effective tool for increasing the productivity of rape seed–mustard in Kangra district of Himachal Pradesh. *Himachal Journal of Agricultural Research, 33*(2), 257–261.

Lalljee, B., & Facknath, S. (2001). Effect of lime on nutrient content of soils, yield and nutrient content of potato and infestation by leaf miners. *Food and Agricultural Research Council*, 139–147.

Majumdar, S., Samborlang, K., Wanniang, & Behera, U. K. (2022). Acid soil management in north eastern hill region of India. *Indian Farming, 72*(3), 72–77.

Marschner, H. (2011). *Marschner's mineral nutrition of higher plants*. London: Academic Press.

Meena, H. M., Sharma, R. P., Sankhyan, N. K., & Sepehya, S. (2017). Effect of continuous application of fertilizers, FYM and lime on soil fertility and productivity of the maize-wheat system in

an acid Alfisol. *Communications in Soil Science and Plant Analysis, 48*(13), 1552–1563.

Oliver, Y. M., Gazey, C., Fisher, J., & Robertson, M. (2021). Dissection of the contributing factors to the variable response of crop yield to surface applied lime in Australia. *Agronomy, 11*(5), 829.

Orton, T. G., Mallawaarachchi, T., Pringle, M. J., Menzies, N. W., Dalal, R. C., & Kopittke, P. M. (2018). Quantifying the economic impact of soil constraints on Australian agriculture: A case-study of wheat. *Land Degradation & Development, 29*(11), 3866–3875.

Panse, V. C., & Sukhatme, P. V. (1989). *Statistical methods for agricultural workers* (4th ed.). New Delhi: ICAR Publication (pp. 34–35).

Praharaj, C. S., Singh, U., Singh, S. S., & Kumar, N. (2017). Micro-irrigation in rainfed pigeon pea – Upscaling productivity under Eastern Gangetic plains with suitable land configuration, population management and supplementary fertigation at critical stages. *Current Science, 112*(1), 95–107.

Satya, M. S. S. C., & Swami, S. (2021). Yield and yield attributes of black gram (*Vigna mungo* L. Hepper) as influenced by phosphorus and boron in acid Inceptisol. *International Journal of Agricultural and Applied Sciences, 1*(2), 73–78.

Subbiah, B. V., & Asija, G. L. (1956). A rapid procedure for determination of available nitrogen in soils. *Current Science, 25*, 259–260.

Swami, S., & Singh, S. (2020). Effect of nitrogen application through urea and *Azolla* on yield, nutrient uptake of rice and soil acidity indices in acidic soil of Meghalaya. *Journal of Environmental Biology, 41*(1), 139–146.

Swami, S., & Yadav, O. S. (2020). Soil properties as influenced by biochar application under integrated nutrient management in acid Inceptisol of Meghalaya. *Journal of Natural Resource Conservation and Management, 1*(2), 104–111.

Walkley, A., & Black, C. A. (1934). An examination of the method for determination of soil organic matter and a proposed modification of the chromic acid titration methods. *Soil Science, 37*, 29–38.

Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/136843