



Plant Archives

Journal homepage: <http://www.plantarchives.org>

DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.2.172>

EFFECT OF AMMONIUM MOLYBDATE AND ZINC SULPHATE ON PRODUCTION OF LENTIL IN ACID SOILS OF LOWER BRAHMAPUTRA VALLEY ZONE OF ASSAM, INDIA

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(Date of Receiving-14-07-2026; Date of Revision-07-09-2026; Date of Acceptance-14-09-2026)

ABSTRACT

A Frontline Demonstration (FLD) on lentil var. HUL-57 by using package 0.5 kg ammonium molybdate + 20 kg ZnSO₄/ha + biofertilizer (*Rhizobium*) seed treatment + 75% of RDF was conducted by Krishi Vigyan Kendra (KVK), Barpeta to find out the grain yield, technological gap, extension gap and economics during 2020-21 and 2021-22. In both the years, lentil variety HUL-57 was used in the demonstration plot considering local variety as control in the farmer's plot. The result of the study revealed that the yield of lentil was found to be 10.2 q/ha and 9.80 q/ha, respectively under the demonstration plot as compared to 9.26 q/ha and 8.7 q/ha, respectively under the farmer's plot and the yield increased by 10.15 and 10.64 per cent, respectively during the year, 2020-21 & 2021-22. The technology gap, extension gap and technology index were found to be 4.3 q/ha & 4.7 q/ha, 0.94 q/ha & 1.0 q/ha, and 30 % & 32 %, respectively during 2020-21 & 2021-22. The net return (Rs. 41380.00 /ha & Rs. 38580.00 /ha, respectively during 2020-21 & 2021-22) and Benefit Cost ratio (2.3 & 2.2, respectively during 2020-21 & 2021-22) were found to be highest under demonstration plot in both the years. The results depict that the seed yield of lentil in the Barpeta district could be enhanced by using package 0.5 kg ammonium molybdate + 20 kg ZnSO₄/ha + biofertilizer (*Rhizobium*) seed treatment + 75% of RDF and lentil var. HUL 57 over local variety.

Key words : Lentil, Ammonium molybdate, ZnSO₄, Yield gap, B:C ratio.

Introduction

Among the first few crops that humans have introduced to cultivation, lentil is one of the major pulses. Asia continues to be the primary producer, consumer and importer of lentils, with India being the most significant nation in terms of production and consumption (Phatate and Gupta, 2024). Lentil (*Lens culinaris* Medic) is the most common form of pulse consumption in the Indian subcontinent. Lentil is from the Leguminosae or Fabaceae family. Thus, it plays a vital function in crop rotation and

improves overall soil fertility status. Due to its great biological value and ease of being cooked, it is also referred to as a patient food. Total biological yield (except roots) can be used for cattle feed purposes. The estimated area under cultivation of lentils in the world is around 4.34 mha. While production is around 4.95 m tons, it has a productivity of 1260 kg/ha (Reda, 2015). Globally, Canada is the leading producer of lentils, followed by India. In India, in the year 2022, the area under lentil cultivation was around 1.42 mha. Production was 1.28 m tons, with a productivity of 904 kg/ha (Reddy *et al.*, 2022). In 2022,

Uttar Pradesh was the highest yield producing state in India. In a 0.49 m ha area, production was 0.47 m tons. The total contribution of Uttar Pradesh to lentil production in India was about 36.4 per cent, the second leading state in India is Madhya Pradesh, with 0.49 m ha of land under lentil cultivation and 0.40 m tons of yield (Sundar Anchra, 2026). Deep sandy loam soil with neutral pH and good drainage is considered to be very good for lentil cultivation. Acidic soil is not suitable for lentil cultivation. With respect to climate, Lentil requires a cold climate for its vegetative growth and a warm climate for reproductive growth as well as maturity (Kullu *et al.*, 2021).

Lentil is a very important source of nutritional security (Togay *et al.*, 2015); protein content around 18 to 30 per cent (Bhatty, 1988); contains several essential micronutrients, e.g. Fe, Zn, β -carotene for improving health of humans and domestic animals.

Pulses help diversify rice-based cropping systems predominant in Lower Brahmaputra Valley Zone (LBVZ) of Assam, while promoting healthy soils and enhancing economical crop production in a cropping system (Kalita *et al.*, 2023). In between two high input intensive crops, one pulse crop with nitrogen (N) fixation traits should, therefore, be incorporated for natural recovery of soil fertility. The incorporation of pulse crops in rice-rice or rice-wheat or rice-maize systems carries over its beneficial effects on the next crops and reduces expenses on chemical provisions (Alam *et al.*, 2016). Yadav *et al.* (2007) found that improved soil physical, chemical and biological properties and increased system productivity were associated with growing lentils in double/triple-crops cropping systems. They attributed to increase yield and improve soil health by biological N fixation or other rotational effects (Nulik *et al.*, 2013). However, soils in the LBVZ of Assam are now reported to be deficient in micronutrients (Choudhari *et al.*, 2019). The management of the micronutrients was, therefore, taken into account to increase the production of lentil in LBVZ of Assam.

Materials and Methods

A Frontline demonstration (FLD) was carried out during the *rabi* seasons of years 2020-21 and 2021-22 in the farmer's field of Barpeta district of Assam in four villages *i.e.*; Datara, Bhella, Rupakuchi and Bhawanipur by Krishi Vigyan Kendra, Barpeta. A total of five farmers were taken covering an area of 0.5 ha each for treatment and control plots totaling an area of 10 ha each year. The demonstration consisted of Application of 0.5 kg ammonium molybdate + 20 kg ZnSO₄/ha + biofertilizer (*Rhizobium*) seed treatment + 75% of RDF and crop variety HUL-57 and one control plot separately for each

farmer. Fertilizers were applied as band placement for which 4-5 cm deep furrows were made along the seed rows with hand hoe. The nutrient sources were Urea, SSP and MOP to fulfill the requirement of nitrogen, phosphorus and potassium. Sulphur, Molybdenum and Zinc were supplied as soil application to the respective plots based on their recommendations. Irrigation was based on the necessity and at the time of sowing. Yield attributes *viz.*; plant height, pods/plant, seeds/pod and yield was recorded with standard basis of observation. Gross cost of cultivation, gross return, net return and B:C ratios were calculated following standard procedure.

Before land preparation was done, farmers were trained to follow package of practices for the demonstration plot. The farmers followed the full package of practice like land preparation, seed treatment, proper seed rate, manure and fertilizer application, weed management and plant protection measures for the demonstration plot. For control plot, the traditional practices of farmers of Barpeta district were followed using existing varieties and cultivation practices.

The data were collected from both demonstration plots and control plots and finally, the extension gap, technology gap, technology index with the cost benefit ratio (Samui *et al.*, 2000) were calculated as follows:

Technology gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield – farmers yield

Technology index = $\frac{\text{Potential yield} - \text{demonstration yield}}{\text{Potential yield}}$

Results and Discussion

The result of the study for two years in four different villages of Barpeta district indicated that, the cultivation practices comprised under the FLD plot produced on an average 10.4 per cent more yield of lentil compared to control plot (Table 3). The application of Zn, S and Mo either single or in combination contributed significantly to increase the seed yield of lentil. This might be attributed to the combination of micronutrient (Zn, B and Mo), which might enhance N-fixation (increased nodules), uptake of nutrients and assimilation of available nutrients by the plants during the whole growth period (Kumar *et al.*, 2009 and Valenciano *et al.*, 2011).

Growth and Yield attributes

Effect of FLD and control study on Growth and Yield Attributes of Lentil *viz.*; plant height, no. of pods/plant, seeds/pod of both the years are presented in Table 3. The Growth parameters were higher in FLD plot in both the year as compared to control check. HUL-57 variety

Table 1 : Mean value of initial Soil fertility status of the five farmers plots of Barpeta district.

pH	OC (%)	Av. N (kg/ha)	Av. P ₂ O ₅ (kg/ha)	Av. K ₂ O (kg/ha)	Zn (mg/kg)
5.8	0.70	233.33	18.4	156.4	0.29

*The value in the table is the mean of five samples of five farmers plot.

while in control it recorded 129.49.

The results, therefore, stated that the combined application of Zn, S and Mo were more efficient in accumulating major essential nutrients in lentil than that of their paired or single applications. Islam *et al.* (2018) conducted a similar study and stated that Zn, S and Mo application alone or in combination demonstrated

Table 2 : Mean Residual Soil fertility status of the five farmer's plots of Barpeta district.

Year	Trial	pH	OC (%)	Av. N (kg/ha)	Av. P ₂ O ₅ (kg/ha)	Av. K ₂ O (kg/ha)	Zn (mg/kg)
2020-21	Demonstration	6.1	0.85	450.3	27.5	150.2	0.48
	Control	5.9	0.70	347.2	18.4	144.2	0.25
2021-22	Demonstration	6.2	0.95	440.3	31.3	138.9	0.90
	Control	5.9	0.72	339.4	19.5	136.3	0.29

*The values in table are the mean of five plots of the five farmers shown year wise.

Table 3 : Yield and its attributes of two years.

Year	Trial	Plant height (cm)	Pods/plant	Seeds/pod	Potential yield (q/ha)	Yield (q/ha)	% increase in yield	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
2020-21	Demonstration	37.50	145.80	2	14.5	10.20	10.15	4.3	0.94	30.0
	Control	33.22	129.38	2		9.26				
2021-22	Demonstration	35.10	135.40	2	14.5	9.80	10.64	4.7	1.1	32.0
	Control	33.00	129.60	2		8.70				
Average increase in yield over two years (%)							10.40			

*The values in table are the means of five farmers shown year wise.

Table 4 : Economics of cultivation of Lentil for two years in farmers field.

Year	Trial	Gross cost (Rs.)	Gross return (Rs.)	Net return (Rs.)	B:C ratio
2020-21	Demonstration	30020.00	71400.00	41380.00	2.3
	Control	32000.00	65100.00	33100.00	2.0
2021-22	Demonstration	30020.00	68600.00	38580.00	2.2
	Control	32000.00	60900.00	28900.00	1.9

*The value in the table are the mean of five farmers shown tear wise.

of lentil considered in the FLD plot produced the maximum seed (10.20 q/ha) yield in the 1st year of study (2020-21). Data in Table 3 revealed a significant increase in plant height in the FLD plots compared to control treatment. The mean data of two years in the (NH₄)₆Mo₇O₂₄ + ZnSO₄ treated plots recorded an average plant height of 36.30 cm, while in control plots it showed 33.11 cm plant height. The number of pods per plant recorded a significant difference between treated plots and control. The mean data of two years in the treated plots recorded an average pods/plant of 140.6

increased concentration of N, P, K, S, Zn and B in lentil. The results are in agreement with the findings of Ziaeyana and Rajaiea (2009).

Initial and Final Soil Fertility status

The mean value of initial soil fertility status of the four villages, that were collected before conducting the study are presented in Table 1. After conducting the study, there is change in the residual soil fertility status in both the years.

The year wise mean value of residual soil fertility status of the four villages are given in Table 2. It was observed that there is increase in organic carbon (OC) in the FLD plot during the study, the highest being in the year 2021-22 (0.95 %); this increase was also seen as compared to the control plot. Similar increase was also observed in case of Av. N (450.3 kg/ha) and Av. K₂O (150.2 kg/ha) in the year 2020-21, while Av. P₂O₅ (31.3 kg/ha) was found to be more in 2021-22. Highest Zn (0.90 mg/kg) was observed in FLD plot in the year 2021-22.

This may be attributed to the proper fertility management in the demonstration plot as compared to the control plot. Zn, S and Mo improve the nutrient uptake by lentil and hence enhance the use efficiency of various nutrients from the soil (Gupta and Gangwar, 2012).

Yield Gap analysis

During the study, the trend of technology gap (ranging from 4.3 – 5.8 q/ha) reflects the farmers' cooperation in carrying out the FLD with encouraging results in the 1st year *i.e.*; 2020-21 (4.3 q/ha). The extension gap in 1st year is 0.94 q/ha while in 2nd year 1.1 q/ha which showed an increasing trend; and also, a narrow range indicating the farmers have adopted the improved cultivation practices in the demonstration plots. It was observed that the technology gap was lower in the year 2020-21 (4.3 q/ha). The lower the value of technology index, the more feasible is the technology. The values of technology index in the 1st year was 30% while in 2nd year it was 32%, in certain region may be attributed to dissimilarity in weather conditions mainly due to non-availability of irrigation water (Thoithoi Devi *et al.*, 2023).

Economics of cultivation

An analysis on economics (Table 4) revealed that lentil in FLD (variety HUL 57) recorded the higher gross return Rs. 71400.00 /ha and net return of Rs. 41380.00 /ha in the first year. The Gross return and net return from lentil cultivation were higher in both the years as compared to control (Farmers practice). The B:C ratio in the FLD plots in both the years of study were almost similar, but were more as compared to the control plots.

Conclusion

Based on the findings of demonstration in one season in two years, it is concluded that application of ammonium molybdate @ 0.5 kg/ha, zinc sulphate @ 20 kg/ha, seed treatment with *Rhizobium* along with 75% recommended doses of NPK was found more helpful for attaining better yields and its attributes in lentil under Lower Brahmaputra Valley Zone of Assam. The practice under demonstration plot is not only the scientific basis for balanced fertilization, but it also enables farmer to choose the proper fertilizer management practices. It can also reduce the technology gap to a considerable extent, which would be beneficial for the farming community.

Acknowledgement

Authors are thankful to the Directorate of Extension Education, Assam Agricultural University and ICAR-ATARI Zone-VI for providing us facilities and support for undertaking the Frontline demonstration.

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