

A review of zinc management in fodder cowpea: Impact on nutrient uptake, soil fertility and economics

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DOI: <https://doi.org/10.66856/ijfsn.2026.11.2.11088>

Abstract

Fodder cowpea (*Vigna unguiculata* L.) is an important leguminous forage crop, valued for its rapid growth, high biomass production, and superior nutritive quality, particularly under dryland and semi-arid conditions. Among the essential micronutrients, zinc plays a crucial role in enhancing crop growth, yield, and quality through its involvement in enzyme activation, energy transfer, root development, nodulation, and various metabolic processes. A comprehensive review of research findings across diverse agro-ecological regions indicates that zinc application significantly improves soil fertility and nutrients uptake. Optimum zinc levels ranging from 20 to 25 kg ZnSO₄ ha⁻¹ consistently recorded superior green and dry fodder yields across seasons and soil types, with higher doses showing marginal or at-par responses. Zinc application also influenced gross returns, net returns and benefit-cost ratio. Overall, the reviewed studies indicate that balanced zinc fertilization contributing to sustainable fodder production and soil fertility management.

Keywords: Cowpea, economics, nutrient uptake and soil fertility management

Introduction

Fodder cowpea (*Vigna unguiculata* L.) is a widely cultivated, drought-tolerant leguminous forage crop known for its rapid growth, high green biomass production, and rich protein content. It plays a crucial role in supporting livestock nutrition, particularly in arid and semi-arid regions, due to its adaptability to dryland farming systems and its ability to fix atmospheric nitrogen, thereby improving soil health. Among the essential nutrients required for optimal fodder cowpea growth, phosphorus (P) and zinc (Zn) stand out due to their key physiological roles. Zinc (Zn) influences the synthesis of growth hormones and supports reproductive processes in certain plants (Prasad, 2007). Zinc plays an important role in chlorophyll formation, carbohydrate metabolism and protein biosynthesis. Zinc is necessary to activate many enzymes like tryptophan synthetase, superoxide dismutase and dehydrogenases. Zinc deficiency impairs RNA and protein biosynthesis leading to a reduction in plant protein content (Singh *et al.*, 2018) [14]. Zinc fertilizer application causes root and shoot growth during the growing season and therefore leading to an increased seed yield. Zinc fertilization is considered as productive and profitable approach for attaining quality fodder (Rengel, 2001) [11].

Nutrient Uptake

Manisha (2021) [7] found that application of 20 kg ZnSO₄ and foliar spray of 0.5% ZnSO₄ at 20 and 40 DAS recorded maximum uptake of NPK and Zn as compared to other treatments in fodder cowpea during kharif season on clay loam soils at ICAR-NDRI, Karnal. Significantly higher zinc uptake was observed with 20 kg ZnSO₄ ha⁻¹ and lowest in control in cluster bean during kharif season on sandy clay

loam soils of Karnal, Haryana (Pandey *et al.*, 2019) [9]. Zn uptake by maize crop with 8 kg Zn ha⁻¹ over the control during kharif season on sandy soils of Agra, Uttar Pradesh (Sandeep and Singh, 2017) [12]. Shivay *et al.* (2014) [13] recorded significantly increased nitrogen uptake with the foliar application of zinc sulphate hepta hydrate (ZnSO₄.7H₂O) @ 5 kg Zn ha⁻¹ and Zn-EDTA @ 2.5 kg Zn ha⁻¹ over single spray or soil application in chickpea. Chavan *et al.* (2012) [3] stated that application of 40 kg zinc sulphate ha⁻¹ increased the uptake of N, P, K and Zn in cowpea during kharif on clay soils of Junagadh, Gujarat. Application of zinc @ 7.5 kg ha⁻¹ resulted in increased uptake of manganese, zinc and copper along with N, P and K in soyabean on clay soils of Rahuri, Maharashtra (Kanase *et al.*, 2008) [5]. Puste and Jana (1995) [10] observed higher nitrogen and phosphorus uptake by seed due to application of 20 kg zinc sulphate ha⁻¹ in pigeonpea during winter season on sandy loam soils of Mohanpur, West Bengal. Application of zinc 4 kg Zn ha⁻¹ found maximum nitrogen and zinc uptake in fodder sorghum (Mithesh *et al.*, 2013) [8].

Post-Harvest Soil Nutrient Status

Arvind *et al.* (2020) [2] concluded that application of zinc @ 20 kg ha⁻¹ significantly increased the nitrogen content and zinc content in fodder maize over control during kharif season at Sabour, Bhagalpur. Higher soil zinc content was found in 20 kg ZnSO₄ treated plot, while 10 kg ZnSO₄ ha⁻¹ and 0.5 % zinc spray treated plot were found statistically at par with each other in cluster bean during kharif season on sandy clay loam soils of Karnal, Haryana (Pandey *et al.*, 2019) [9]. Kumar *et al.* (2017) [6] observed that application 20 kg ha⁻¹ ZnSO₄ as basal dose resulted higher zinc content and uptake, in fodder maize during kharif season on sandy clay

loam soil of Karnal, Haryana. Sandeep and Singh (2017) ^[12] stated that application of 6 kg Zn ha⁻¹ recorded maximum available nutrients after maize crop during kharif season on sandy soils of Agra, Uttar Pradesh.

Economics

A field experiment conducted by Arvind *et al.* (2020) ^[2] recorded the higher net returns and benefit cost ratio with the zinc level of 10 kg ha⁻¹ which was statistically at par with zinc level of 20 kg ha⁻¹ in fodder maize during kharif season Sabour, Bhagalpur. Manisha (2021) ^[7] noticed application of 20 kg ZnSO₄ as basal resulted in significantly higher gross returns as well as net returns of cowpea were obtained with application of 20 kg ZnSO₄ during kharif season on clay loam soils at ICAR-NDRI, Karnal. Maximum B:C ratio was recorded with ZnSO₄ 20 kg ha⁻¹ + rhizobium 100g 10 kg⁻¹ of seed in field pea during *rabi* season in inceptisols of Allahabad (Verma *et al.*, 2018) ^[17]. Maximum net returns and B:C ratio were obtained with application of 20 kg ZnSO₄ ha⁻¹ in *rabi* chickpea on sandy loam soils at Allahabad, Uttar Pradesh (Siva and George, 2017) ^[15]. Application of 25 kg ZnSO₄ ha⁻¹ recorded maximum net returns as compared to other treatments in fodder pearl millet in sandy loam soils of Ajmer, Rajasthan (Gajendra *et al.*, 2016) ^[4]. Anil *et al.* (2014) ^[1] noticed that maximum gross returns, net returns and B:C ratio were obtained with application of zinc 30 kg ha⁻¹ on sandy clay loam soils during *rabi* season at Chirakoot, Madhya Pradesh. Maximum net returns and B:C ratio was found with application of zinc 25 kg ha⁻¹ in fodder maize during kharif season on sandy loam soils of Prayagraj, Uttar Pradesh (Thakur *et al.*, 2013) ^[16].

Conclusion

The collective evidence from various studies clearly demonstrates the pivotal role of zinc nutrition in nutrient uptake and soil fertility of fodder cowpea. Application of zinc significantly improved availability of nutrients like N, P and K. zinc levels in the range of 20-25 kg ZnSO₄ ha⁻¹ were found to be optimum under most soil and climatic conditions, ensuring efficient nutrient use. Adequate zinc supply also favourably influenced economics of fodder cowpea. Therefore, judicious zinc management, sustaining soil health in fodder-based cropping systems.

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