



## Effect of Nutrient Management on Fodder Yield of Sorghum (*Sorghum bicolor*)

\*B Soumya Sri, D Sri Charan, A Pravalika, M Ashritha Yadav, P Sangeetha and Dr. J Aruna Kumari

Professor Jayashankar Telangana Agricultural University, Hyderabad, India

\*Corresponding Author's email: [soumyasribashetti@gmail.com](mailto:soumyasribashetti@gmail.com)

Sorghum (*Sorghum bicolor* L.) is an important fodder crop widely grown in semi-arid and tropical regions due to its high biomass production and drought tolerance. Nutrient management plays a crucial role in improving the growth and fodder yield of sorghum. Adequate supply of essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K) significantly enhances plant growth, leaf development, and overall biomass production. Nitrogen promotes vigorous vegetative growth and increases chlorophyll content, leading to higher green fodder yield. Phosphorus supports root development, early plant establishment, and efficient energy transfer, which contributes to better crop growth. Potassium improves water use efficiency, strengthens plant tissues, and enhances tolerance to environmental stress. In addition to macronutrients, micronutrients such as zinc play an important role in enzyme activation, protein synthesis, and improved nutrient uptake. Balanced fertilization and integrated nutrient management practices can therefore improve sorghum productivity, fodder quality, and soil fertility. Thus, proper nutrient application is essential for maximizing sorghum fodder yield and sustaining fodder production in agricultural systems.

**Key words:** Sorghum, fodder sorghum, nutrient management, sorghum fodder yield, crop productivity, soil fertility

### Introduction

*Sorghum bicolor* (sorghum) is one of the most important fodder crops grown in tropical and semi-arid regions due to its high biomass production, drought tolerance, and adaptability to different soil conditions. It is widely cultivated for green fodder to support livestock production. The productivity and quality of sorghum fodder largely depend on proper nutrient management. Nutrients play a vital role in the growth and development of sorghum plants. Essential macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) are required in larger quantities for proper plant growth. Nitrogen is particularly important for vegetative growth, leaf formation, and chlorophyll production, which directly influence the green fodder yield. Phosphorus promotes root development, early crop establishment, and efficient energy transfer within the plant, while potassium helps regulate water balance, improves disease resistance, and enhances overall plant vigor. In addition to macronutrients, micronutrients such as zinc, iron, and manganese are also necessary in smaller quantities for enzyme activation and metabolic processes. Deficiency of these nutrients can limit plant growth and reduce fodder yield and quality. Therefore, balanced fertilization and efficient nutrient management practices are essential to maximize sorghum fodder production and maintain soil fertility. Understanding the effect of nutrients on sorghum fodder yield helps farmers adopt suitable fertilization strategies to improve productivity, fodder quality, and sustainability of livestock-based farming systems.

## Effect of nitrogen on fodder yield

Nitrogen is considered the primary yield-limiting nutrient in sorghum-based fodder systems. The studies mainly rely on: agronomic efficiency (AE) - yield increase per unit N applied; partial factor productivity (PEP) - yield per unit of applied N; and apparent recovery (qualitative) - inferred from N uptake data.

Somashekar *et al.*, 2015- Multicut Fodder Sorghum: The main objective is to optimise the seed rate and nitrogen dose per cut for maximising fodder yield. The nitrogen management strategy they followed N levels :15,30,45,60 kg N ha<sup>-1</sup> and they followed split application as in basal N, top dressing at 30 & 45 DAS and at post-cut N application-key for NUE in multicut systems and the experimental designs they followed RBD, factorial with 12 treatments, 3 replications for four cuts pooled- improves NUE inference over time and the instruments & methodologies they followed for dry matter production- hot air oven and for the yield estimation-plot harvest-hectare conversion and for the statistics they used ANOVA, CD at 5% and the efficiency of N is 30 kg N ha<sup>-1</sup> per cut achieved comparable yield to 45-60 kg N and the highest B:C ratio (2.20) and indicates diminishing returns beyond 30 kg N, a classic NUE response and the authors cited for n response are Dudhat *et al.* (2004), Sharma & Verma (2005) and Sheoran & Rana (2006) and the interpretation of NUE is moderate N+proper split timing =higher efficiency than high N doses.

The nitrogen and zinc interaction was given by Bhoya *et al.*, and the study focused mainly on the how N & Zn interaction improves yield, quality, and nutrient uptake and N treatments they followed 40,80,120 kg N ha<sup>-1</sup> and split application is 50% basal+50% at 35 DAS and the experimental design used is factorial RBD and instruments & analytical methods for nitrogen estimation is kjeldahl method and crude protein N x 6.25 and Zn estimation chemical extraction(DTPA- based) and statistical tool is ANOVA and the related results are 120 kg N ha<sup>-1</sup> maximum N uptake and high crude protein and Zn @ 4 kg ha<sup>-1</sup> enhanced N uptake, showing synergistic NUE improvement and the authors are Bhilare *et al.* (2002), Giri *et al.* (2006) and Gupta *et al.* (2008). To identify N efficient fodder sorghum genotypes Pushpendra Singh & Sumeriya done the N treatments 0,40,80,120 kg ha<sup>-1</sup> and the experimental design followed is split- plot design and the genotypes are (main plot) x N(sub-plot) and the instruments and methods used are nitrogen estimation is modified kjeldahl, crude fibre-wright method, ether extract-soxhlet apparatus and for the Ash-muffle furnace and the key findings are Application of 80 kg N ha<sup>-1</sup> yield and quality at par with 120 kg N and the genotype SU-1080 yield high and the authors are Dixit *et al.* and Sumeriya *et al.* and the result concluded that the genotype selection is an important as N dose in improving efficiency.

## Impact of phosphorus on fodder yield

Pushpendra Singh *et al.* (2012) explored how nitrogen (N) and phosphorus (P) impact fodder sorghum yield, quality, and economics. Nitrogen (N) 80 kg N/ha boosted growth (height, leaves, biomass), yield, increased crude protein and fat content. Highest economic returns and B:C ratio at 80 kg N/ha; Phosphorus (P): 40 kg P<sub>2</sub>O<sub>5</sub>/ha improved growth and yield. Enhanced dry matter and fodder production. Combined N + P: 120 kg N + 60 kg P<sub>2</sub>O<sub>5</sub>/ha maximized crude protein and protein yield. The conclusion here is Balanced N and P (80 kg N + 40 kg P<sub>2</sub>O<sub>5</sub>/ha) is the sweet spot for yield, quality, and profit in fodder sorghum. Pushpendra Singh *et al.* (2012) found that balanced nitrogen (80 kg N/ha) and phosphorus (40 kg P<sub>2</sub>O<sub>5</sub>/ha) fertilization boosts fodder sorghum yield, quality, and profitability. The benefits are improved growth and yield, enhanced crude protein and fat content, Highest economic returns and B:C ratio. Recommended dose: 80 kg N + 40 kg P<sub>2</sub>O<sub>5</sub>/ha. Muhammad Rashid *et al.* (2007) explored phosphorus (P) fertilization for sorghum fodder in Pakistan's Ustochrept soil. P Fertilization Impacts the boosted yield and quality (crude protein ↑ from 6.37% to 9.97%). Optimum P dose: 83 kg P/ha. Soil & Plant P Needs: External P requirement: 0.31 mg/L soil solution for 95% yield. Internal P requirement: 0.26% in plant tissue. Freundlich Model: Effective for determining P doses, considering soil's alkaline nature (pH 8.0) and P

fixation. The final conclusion is Model-based P fertilization improves sorghum fodder yield, quality, and livestock nutrition.

### **Nutrient Effects on Fodder Yield and Crop Interaction in Sorghum–Legume Intercropping Systems**

Sorghum–legume intercropping is an efficient and sustainable fodder production system widely adopted to improve biomass yield, fodder quality, and soil fertility. Legumes such as cowpea, soybean, and clusterbean contribute to nitrogen enrichment through biological nitrogen fixation. Nutrient availability, particularly nitrogen, plays a critical role in determining fodder yield and quality in sorghum-based intercropping systems. Legumes fix atmospheric nitrogen and improve soil nitrogen status, which benefits the companion sorghum crop by increasing vegetative growth, biomass accumulation, and crude protein content. Studies have shown that sorghum intercropped with legumes often requires reduced chemical nitrogen fertilizer without significant yield reduction, indicating improved nitrogen use efficiency. Phosphorus and potassium also influence crop interactions and fodder production. Phosphorus promotes root growth, energy transfer, and nodulation in legumes, thereby supporting better nutrient uptake and biomass production. Potassium improves nutrient translocation, water use efficiency, and stem strength, contributing to yield stability in intercropping systems. Improved root distribution and microbial activity in the rhizosphere enhance the availability and uptake of these nutrients. Sorghum–legume intercropping generally results in higher green fodder and dry matter yield compared to sole sorghum. Inclusion of legumes improves fodder quality by increasing crude protein content and reducing fiber concentration, making the fodder more nutritious for livestock. The advantages of intercropping are often reflected in higher land equivalent ratio values, indicating more efficient use of land and nutrients.

### **Integrated Use of Organic and Inorganic Fertilizers**

The drought tolerance and great palatability of sorghum (*Sorghum bicolor* L.) make it an advantageous feed crop, especially in semi-arid locations like Ethiopia, Pakistan, Sudan, and India (Hingra et al., 1995) (Akram et al., 2007). However, fodder yield is frequently constrained by insufficient soil fertility and the high expense of synthetic fertilizers (Bayu et al., 2002) (Ojeniyi, 2000; Ayoola, O. T. and Adeniyani, 2008; Obi and Ebo, 1995).

#### **Growth attributes and morphological traits**

When organic and inorganic amendments are used together for integrated nutrient management, fodder sorghum grows vegetatively far better than when traditional applications are used separately or when the crop is left unfertilized. Plant height: INM treatments are consistently associated with taller plants. Very tall plants (175.7 cm) were generated by a recommended dose of NP (@ 75:60 kg/ha), which is comparable to 50% NP + 50% poultry manure (PM) combination (Ahmad et al., 2007). A maximum plant height of 201 cm was achieved by applying PM, Biochar (BC), Press Mud (MUD), and 1/2 NPK together (Sher et al., 2022). Leaf production and area: Compared to integrated or synthetic sources, the slower availability of nutrients in only organic treatments may be the cause of the observed decrease in leaf area (Ahmad et al., 2007). Stem characteristics: INM also results in an increase in stem diameter and dry weight. The combined adjustments produced high stem dry weight and a stem diameter (Sher et al., 2022).

#### **Green and dry fodder yields**

Green fodder yield: 46 t/ha was obtained using all of the inorganic fertilizers that was recommended; however, a 50% NP + 50% PM combination produced 43 t/ha, indicating that organic sources can successfully compensate synthetic inputs (Ahmad et al., 2007). applied half of the recommended NPK and multi-source organic amendments to record an increased green forage yield of 31.8 Mg/ha (Sher et al., 2022). Dry biomass yield: In semi-arid areas such as Ethiopia, 50% of the recommended inorganic fertilizers combined with farmyard manure (FYM) produced grain and biomass yields that were on par with or higher than those obtained with inorganic fertilizer solely. (Bayu et al., 2006). The highest dry forage production

was achieved in organic-only treatments when 5 tons of chicken manure was used per hectare. (Ismaeil et al., 2012)

### Nutritional quality and nutrient uptake

INM systems will have a major effect on the forage crops' quality in addition to biomass. Crude Protein (CP): the use of FYM raises grain protein concentration by 20–29% (Bayu et al., 2006). Additionally, it was noted that the combined use of PM, BC, MUD, and ½ NPK resulted in the highest CP levels (Sher et al., 2022). Nutrient consumption: Nitrogen (N), phosphorus (P), and potassium (K) consumption are improved by the combined application of organic and inorganic fertilizers. The overall N uptake increased by 21–36% in FYM (Bayu et al., 2006).

### Conclusion

Balanced fertilization, efficient nitrogen management, and integrated nutrient strategies are essential to maximize sorghum fodder yield and improve forage quality. Proper nutrient management not only enhances biomass production but also supports sustainable soil fertility and livestock feed availability. Adequate supply of macronutrients such as nitrogen (N), phosphorus (P), and potassium (K), along with essential micronutrients, significantly enhances vegetative growth, nutrient uptake, and overall fodder yield. Nitrogen is considered the most important nutrient influencing sorghum fodder production. Increased nitrogen fertilization improves plant height, leaf area, dry matter accumulation, and green fodder yield. Phosphorus and potassium also play an important role in enhancing root development, nutrient absorption, and stress tolerance. The combined application of phosphorus and potassium significantly improved fodder yield and quality of sorghum grown under arid soil conditions. Integrated nutrient management further improves sorghum productivity.

### References

1. Akram A, Fatima M, Ali S, Jilani G, Asghar R. Growth, yield and nutrients uptake of sorghum in response to integrated phosphorus and potassium management. *Pakistan Journal of Botany*. 2007;39(4):1083-1087.
2. Afzal, M., Ahmad, A. and Ahmad, A.U.H., 2012. Effect of nitrogen on growth and yield of sorghum forage (*Sorghum bicolor* (L.) Moench cv.) under three cuttings system.
3. Almodares, A., Jafarinia, M. and Hadi, M.R., 2009. The effects of nitrogen fertilizer on chemical compositions in corn and sweet sorghum. *American-Eurasian Journal of Agricultural and Environmental Sciences* . 6(4), .441-446.
4. Ayoola, O. T. and O. N. Adeniyani (2008). Influence of poultry manure and NPK fertilizer on yield and yield components of crops under different cropping systems in south west Nigeria. *African Journal of Biotechnology*. 5 (15), 1386-1392
5. Ayub, M., Nadeem, M.A., Tanveer, A. and Husnain, A., 2002. Effect of different levels of nitrogen and harvesting times on the growth, yield and quality of sorghum fodder. *Asian J. Plant Sci*. 1(4), .304-307.
6. Aziz, A., Khan, B.A., Tahir, M.A., Nadeem, M.A., Amin, M.M., Qura-Tul-Ain, M.A., Munawar, N., Hussain, A., Khisham10, M., Danish, M. and Toor11, M.S., 2020. Effect of poultry manure on growth and yield of forage sorghum (*Sorghum bicolor* L.). *Int J Botany Stud*, 5(3), 401-406.
7. Azraf-ul-Haq Ahmad, I.Q. and Mahmood, N., 2007. Effect of integrated use of organic and inorganic fertilizers on fodder yield of sorghum (*Sorghum bicolor* L.). *Pak. J. Agri. Sci*, 44(3), 415-419.
8. Bayu, W., Rethman, N.F.G., Hammes, P.S. and Alemu, G., 2006. Effects of farmyard manure and inorganic fertilizers on sorghum growth, yield, and nitrogen use in a semi-arid area of Ethiopia. *Journal of plant nutrition*, 29(2), 391-407.
9. Hingra, S.H., B. Davis and M.J.A. Akhtar. 1995. Fodder Production. Food and Agricultural Organization of the United Nations, 8.

10. Ismaeil, F.M., Abusuwar, A.O. and El Naim, A.M., 2012. Influence of chicken manure on growth and yield of forage sorghum (*Sorghum bicolor* L. Moench). *International Journal of Agriculture and Forestry*, 2(2), 56-60.
11. Kanavi, M.S.P., 2020. Performance of sorghum under sorghum legume intercropping system. *Journal of Pharmacognosy and Phytochemistry*.9(1), .2320-2322.
12. Mahmud, K., Ahmad, I. and Ayub, M., 2003. Effect of nitrogen and phosphorus on the fodder yield and quality of two sorghum cultivars (*Sorghum bicolor* L.). *International Journal of Agriculture and Biology* .5(1).61-63.
13. Meena, A.K., Singh, P. and Kanwar, P., 2012. Effect of nitrogen levels on yield and quality of [*Sorghum bicolor* (L.) Moench] sorghum genotypes. *Forage Research*.37(4), .238-240.
14. Muhammad Rashid, M.R., Ranjha, A.M. and Abdur Rehim, A.R., 2007. Model based P fertilization to improve yield and quality of sorghum (*Sorghum bicolor* L.) fodder on an Ustochrept soil.
15. Ojeniyi SO (2000) .Effect of goat manure on soil nutrients and okra yield in a rain forest area of Nigeria. *Applied Tropical Agriculture* 5:20-23
16. Palm, C. A., R. J. K. Myers, and S. M. Nandwa. 1997. Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. In *Replenishing soil fertility in Africa*, eds. R. J. Buresh, P. A.Sanchez, and F. Calhoun, Special Publication No. 51, 193–217. Madison,WI: Soil Science Society of America.
17. Rashid, M., Ranjha, A.M. and Rehim, A., 2007. Model based P fertilization to improve yield and quality of sorghum (*Sorghum bicolor* L.) fodder on an ustochrept soil. *Pak. J. Agri. Sci*, 44, .221-227.
18. Satyanarayana, V., P. V. V. Prasad, V. R. K. Murthy, and K. J. Boote. 2002.Influence of integrated use of farmyard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. *Journal of Plant Nutrition* 25: 2081–2090.
19. Sher, A., Adnan, M., Sattar, A., Ul-Allah, S., Ijaz, M., Hassan, M.U., Manaf, A., Qayyum, A., Elesawy, B.H., Ismail, K.A. and Gharib, A.F., 2022. Combined application of organic and inorganic amendments improved the yield and nutritional quality of forage sorghum. *Agronomy*, 12(4), 896.
20. Singh, P.U.S.H.P.E.N.D.R.A., Sumeriya, H.K., Solanki, N.S. and Murdia, A.Z.A.D., 2012. Productivity, economics and quality of fodder sorghum under varying levels of nitrogen and phosphorus. *Annals of Plant and Soil Research*. 14(2), 127-129.
21. Singh, P. and Sumeriya, H.K., 2012. Effect of nitrogen on yield, economics and quality of fodder sorghum genotypes. *Annals of plant and soil Research*.14(2), 133-135.
22. Rashid, M., Ranjha, A.M. and Rehim, A., 2007. Model based P fertilization to improve yield and quality of sorghum (*Sorghum bicolor* L.) fodder on an ustochrept soil. *Pak. J. Agri. Sci*, 44, .221-227.