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**Glory KS**
Assistant Professors (Soil science and Agricultural Chemistry), Krishna College of Agriculture and Technology, Usilampatti, Tamil Nadu, India

**S Prasath**
Assistant Professors (Soil science and Agricultural Chemistry), Krishna College of Agriculture and Technology, Usilampatti, Tamil Nadu, India

**Anbumozhi C**
Assistant Professors (Soil science and Agricultural Chemistry), Krishna College of Agriculture and Technology, Usilampatti, Tamil Nadu, India

**Arunmozhi M**
Assistant Professors (Soil science and Agricultural Chemistry), Krishna College of Agriculture and Technology, Usilampatti, Tamil Nadu, India

**Yazhini R**
Assistant Professors (Soil science and Agricultural Chemistry), Krishna College of Agriculture and Technology, Usilampatti, Tamil Nadu, India

**Corresponding Author:**
**Glory KS**
Assistant Professors (Soil science and Agricultural Chemistry), Krishna College of Agriculture and Technology, Usilampatti, Tamil Nadu, India

# Effect of different nutrient solution levels on growth and nutritional quality of maize fodder varieties under hydroponic conditions

**Glory KS, S Prasath, Anbumozhi C, Arunmozhi M and Yazhini R**

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**Abstract**
The present study was conducted to evaluate the effect of different nutrient solution levels on the growth and nutritional quality of hydroponically grown maize fodder varieties under controlled conditions at Krishna College of Agriculture and Technology, Usilampatti during May 2026. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with two factors comprising four nutrient levels and four maize fodder varieties. The nutrient treatments included T1 (control: water alone), T2 (0.25% NPK spray, 19:19:19), T3 (0.50% NPK spray, 19:19:19), and T4 (0.75% NPK spray, 19:19:19), while the maize varieties included Yayati Hybrid, CO 6, African Tall, and CO H(M)4. Nutritional quality parameters such as dry matter content, crude protein, crude fibre, total ash, and nitrogen-free extract were analyzed using standard AOAC procedures. Results revealed significant differences among nutrient levels and maize varieties for all measured parameters. The application of 0.75% NPK (T4) significantly enhanced dry matter accumulation, crude protein, crude fibre, and total ash content compared with the control treatment. Among the varieties, Yayati Hybrid exhibited superior performance for most nutritional parameters, indicating better nutrient utilization efficiency under hydroponic conditions. Nitrogen-free extract showed a decreasing trend with increasing nutrient concentration, suggesting utilization of soluble carbohydrates for structural and protein synthesis. The findings indicate that appropriate nutrient management through nutrient solution application can significantly improve the nutritional quality and production efficiency of hydroponic maize fodder systems. Therefore, application of 0.75% NPK along with suitable variety selection may be recommended for improving hydroponic fodder production.

**Keywords:** Hydroponics, maize fodder, nutrient solution, NPK, crude protein, dry matter, hydroponic green fodder, nutritional quality

## Introduction
Livestock production plays a vital role in agricultural economies by contributing substantially to food security and rural livelihoods. Availability of quality green fodder remains one of the major constraints affecting livestock productivity in many developing countries. Rapid urbanization, shrinking agricultural land, irregular rainfall patterns, and water scarcity have created significant challenges in sustaining conventional fodder production systems. Consequently, alternative technologies for year-round production of quality fodder have become increasingly important. Hydroponic fodder production is a modern technique involving the cultivation of plants without soil under controlled environmental conditions. Hydroponics enables rapid production of fresh green fodder within a short period, usually between 7 and 14 days, with considerably less water requirement compared to conventional cultivation systems. Studies have indicated that hydroponic systems require approximately 2–10% of the water needed for field cultivation while maintaining high biomass productivity and improved nutritional quality (Naik *et al*., 2015; Al-Karaki and Al-Hashimi, 2012) [9, 1].

Maize is one of the most widely cultivated fodder crops because of its high biomass production potential, excellent palatability, digestibility, and nutritional composition. Hydroponically produced maize fodder has gained considerable attention because it can serve as a dependable feed resource throughout the year (Sneath and McIntosh, 2003) [11].

The nutritional quality of hydroponic fodder is strongly influenced by nutrient availability and varietal characteristics. Balanced nutrient management plays a critical role in regulating plant growth and development. Nitrogen, phosphorus, and potassium are essential macronutrients involved in physiological processes such as photosynthesis, protein synthesis, root development, and carbohydrate metabolism (Peer and Baxter, 2013) [10]. Adequate nutrient supply through nutrient solutions can improve nutrient uptake efficiency and ultimately enhance the nutritional composition of hydroponic fodder (Naik *et al*., 2015; Dung *et al*., 2010) [9, 3]. Different maize varieties may exhibit variation in nutrient uptake efficiency and response to nutrient application. Understanding the interaction between nutrient levels and varietal performance under hydroponic conditions is important for identifying suitable nutrient management strategies for maximizing fodder quality.

Considering the importance of nutrient management in hydroponic fodder systems, the present investigation was undertaken with the following objective:

To evaluate the effect of different nutrient solution levels on growth and nutritional quality of maize fodder varieties under hydroponic conditions.

## Materials and Methods

The present experiment was conducted under hydroponic growing conditions at Krishna college of Agriculture and Technology, Usilampatti during the month of May 2026. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) consisting of two factors. Factor I: Nutrient levels (T1 = Control (water alone), T2 = 0.25% NPK spray (19:19:19), T3 = 0.50% NPK spray (19:19:19), T4 = 0.75% NPK spray (19:19:19)) Factor II: Maize fodder varieties (V1 = Yayati Hybrid, V2 = CO 6, V3 = African Tall, V4 = CO H(M)4). Healthy and uniform seeds of different maize varieties were selected and cleaned prior to sowing. Seeds were soaked in water for an appropriate duration and subsequently incubated for germination. Germinated seeds were uniformly spread in hydroponic trays under controlled conditions. Nutrient solutions were prepared according to treatment concentrations using water-soluble fertilizer (19:19:19 NPK). The nutrient solution was applied according to treatment schedules. The following parameters were recorded: Dry matter content (%), Crude protein (%), Crude fibre (%), Total ash (%), Nitrogen-free extract (%). Proximate composition was determined according to AOAC (2005) procedures.

### Statistical Analysis

Experimental data were statistically analyzed according to the methods described by Gomez and Gomez (1984) [7]. Treatment means were compared using critical difference at the 5% level of significance.

## Results and Discussion

### Effect of nutrient solution levels and maize varieties on dry matter content

Dry matter content varied significantly among nutrient levels and maize varieties during different growth periods (Table 1). At 0 DAS, no significant differences among nutrient treatments were observed, with a uniform value of 52.93%. At 7 DAS, nutrient treatments significantly influenced dry matter accumulation and the highest value was recorded under T4 (0.75% NPK) (17.86%), whereas the lowest value was observed in T1 (control) (17.46%). Similar trends were observed at 14 DAS where treatment differences remained significant.

Among maize varieties, Yayati Hybrid (V1) recorded the highest dry matter content at 7 DAS (19.41%), whereas CO H(M)4 (V4) showed the highest value at 14 DAS (22.39%). Increased dry matter accumulation under nutrient-treated plants may be due to enhanced photosynthetic activity and efficient nutrient utilization resulting from increased nutrient availability. Nitrogen is an important component of chlorophyll and proteins which directly contributes to biomass production and dry matter accumulation. Similar observations were reported by Fazaeli *et al*. (2012) [5], Naik *et al*. (2015) [9], and El-Morsy *et al*. (2013) [4].

### Effect of nutrient solution levels and maize varieties on crude protein content

Crude protein content increased significantly with increasing nutrient concentration during crop growth stages. At 14 DAS, T4 (0.75% NPK) recorded the highest crude protein content (20.66%), whereas the lowest value was observed under T1 (19.02%). The increase in crude protein content may be attributed to increased nitrogen availability from nutrient application, resulting in enhanced amino acid synthesis and protein accumulation. Among maize varieties, Yayati Hybrid (V1) recorded the highest crude protein content (20.15%), followed by CO 6 (19.92%). African Tall (V3) showed comparatively lower protein content (19.46%). Enhanced nitrogen uptake under nutrient-treated conditions likely improved protein synthesis and metabolic activities within the plant tissues. Similar findings were reported by Naik *et al*. (2015) [9], Dung *et al*. (2010) [3], and Gebremedhin (2015) [6], who observed increased crude protein levels in hydroponically grown fodder crops following nutrient supplementation.

### Effect of nutrient solution levels and maize varieties on crude fibre content

Crude fibre content increased progressively with increasing nutrient concentration. Among nutrient treatments, T4 recorded the highest crude fibre content (13.90%), whereas T1 recorded the lowest value (13.49%) at 14 DAS. Among the varieties, Yayati Hybrid (V1) exhibited maximum crude fibre content (13.96%) followed by CO 6 (13.71%), while African Tall (13.54%) and CO H(M)4 (13.53%) recorded relatively lower values. The increase in fibre content may be associated with the development of structural components such as cellulose and lignin during plant growth. Nutrient availability enhances physiological activities that contribute to cell wall formation and tissue development. Similar observations were reported by Morgan *et al*. (1992) [8].

### Effect of nutrient solution levels and maize varieties on total ash content

Total ash content represents mineral accumulation within plant tissues and differed significantly among nutrient treatments and varieties. Among nutrient treatments, T4 recorded the highest total ash content (4.18%), while T2 recorded the lowest value (3.90%) at 14 DAS.

Among maize varieties, Yayati Hybrid recorded the highest total ash content (4.13%), whereas African Tall recorded the lowest value (3.92%). Increased mineral accumulation under

nutrient treatments may be due to improved nutrient uptake efficiency and enhanced metabolic activity. These findings agree with reports of Fazaeli *et al*. (2012) [5] and Al-Karaki and Al-Hashimi (2012) [1].

**Effect of nutrient solution levels and maize varieties on nitrogen free extract**

Nitrogen-free extract (NFE) showed a decreasing trend with increasing nutrient concentration. At 14 DAS, T1 recorded the highest value (54.19%) while T4 recorded the lowest value (51.86%).

Among varieties, African Tall recorded the highest NFE value (53.96%), while Yayati Hybrid recorded the lowest value (52.39%). The reduction in NFE under higher nutrient treatments may indicate utilization of soluble carbohydrates for synthesis of proteins and structural compounds during plant growth. Similar observations were reported by Naik *et al*. (2015) [9] and Dung *et al*. (2010) [3].

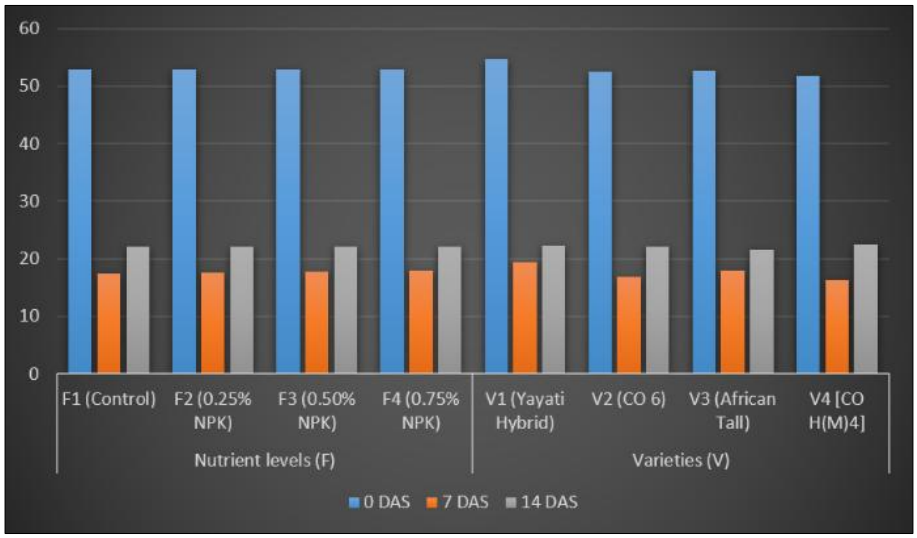


**Fig 1:** Effect of nutrient solution spray (19:19:19) and varieties on Dry matter content

**Table 1:** Effect of nutrient solution spray (19:19:19) and varieties on various parameters in maize varieties grown hydroponically

| | Dry Matter Content | | | Crude protein content | | | Crude fibre content | | | Total ash content | | | Nitrogen free extract | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Treatment/Variety** | **0 DAS** | **7 DAS** | **14 DAS** | **0 DAS** | **7 DAS** | **14 DAS** | **0 DAS** | **7 DAS** | **14 DAS** | **0 DAS** | **7 DAS** | **14 DAS** | **0 DAS** | **7 DAS** | **14 DAS** |
| **Factor I: Nutrient levels (F)** | | | | | | | | | | | | | | | |
| F1 (Control) | 52.93 | 17.46 | 22.14 | 10.27 | 10.27 | 19.02 | 2.41 | 13.49 | 13.49 | 1.56 | 3.81 | 3.96 | 83.43 | 65.47 | 54.19 |
| F2 (0.25% NPK) | 52.93 | 17.56 | 22.05 | 10.24 | 10.24 | 19.45 | 2.43 | 13.63 | 13.63 | 1.54 | 3.83 | 3.90 | 83.42 | 64.67 | 53.51 |
| F3 (0.50% NPK) | 52.93 | 17.68 | 22.10 | 10.28 | 10.28 | 20.00 | 2.41 | 13.72 | 13.72 | 1.56 | 3.87 | 4.07 | 83.39 | 64.04 | 52.77 |
| F4 (0.75% NPK) | 52.93 | 17.86 | 22.06 | 10.34 | 10.34 | 20.66 | 2.43 | 13.90 | 13.90 | 1.55 | 3.92 | 4.18 | 83.40 | 63.06 | 51.86 |
| **Factor II: Varieties (V)** | | | | | | | | | | | | | | | |
| V1 (Yayati Hybrid) | 54.74 | 19.41 | 22.27 | 10.46 | 10.46 | 20.15 | 2.46 | 13.96 | 13.96 | 1.58 | 3.91 | 4.13 | 82.95 | 63.85 | 52.39 |
| V2 (CO 6) | 52.52 | 16.91 | 22.15 | 10.33 | 10.33 | 19.92 | 2.42 | 13.71 | 13.71 | 1.56 | 3.88 | 4.08 | 83.18 | 64.28 | 53.01 |
| V3 (African Tall) | 52.76 | 18.01 | 21.56 | 10.18 | 10.18 | 19.46 | 2.40 | 13.54 | 13.54 | 1.53 | 3.79 | 3.92 | 83.79 | 64.89 | 53.96 |
| V4 [CO H(M)4] | 51.71 | 16.23 | 22.39 | 10.16 | 10.16 | 19.58 | 2.40 | 13.53 | 13.53 | 1.54 | 3.84 | 3.98 | 83.72 | 64.22 | 52.97 |
| **SE(d)** | | | | | | | | | | | | | | | |
| Fertilizer (F) | 0.0028 | 0.0037 | 0.0025 | 0.0273 | 0.0273 | 0.0257 | 0.018 | 0.023 | 0.023 | 0.008 | 0.014 | 0.016 | 0.028 | 0.036 | 0.041 |
| Variety (V) | 0.0028 | 0.0037 | 0.0025 | 0.0273 | 0.0273 | 0.0257 | 0.018 | 0.023 | 0.023 | 0.008 | 0.014 | 0.016 | 0.028 | 0.036 | 0.041 |
| F × V | 0.0057 | 0.0075 | 0.0051 | 0.0546 | 0.0546 | 0.0514 | 0.036 | 0.046 | 0.046 | 0.016 | 0.028 | 0.032 | 0.056 | 0.072 | 0.082 |
| **CD at 1%** | | | | | | | | | | | | | | | |
| Fertilizer (F) | 0.0118 | 0.0154 | 0.0106 | NS | NS | 0.1065 | NS | 0.095 | 0.095 | NS | 0.058 | 0.066 | NS | 0.148 | 0.170 |
| Variety (V) | NS | 0.0154 | 0.0106 | NS | NS | 0.1065 | NS | 0.095 | 0.095 | NS | 0.058 | 0.066 | NS | 0.148 | 0.170 |
| F × V | NS | 0.0309 | 0.0212 | NS | NS | 0.2131 | NS | 0.190 | 0.190 | NS | 0.116 | 0.132 | NS | 0.296 | 0.340 |

## Conclusion

The present investigation demonstrated that nutrient solution levels significantly influenced the nutritional quality of hydroponically grown maize fodder. Increasing NPK concentration improved dry matter accumulation, crude protein, crude fibre, and mineral content. Among nutrient levels, T4 (0.75% NPK) showed superior performance in improving crude protein, crude fibre and total ash content. Varietal differences were also observed, indicating differential response among maize genotypes. Among the varieties tested, Yayati Hybrid performed better with respect to most nutritional parameters, indicating its suitability for hydroponic fodder production. The findings suggest that optimum nutrient management can improve the quality and efficiency of hydroponic fodder production systems.

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