Plant Archives Vol. 26, No. 1, 2026 pp. 385-390 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

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

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.1.053

EFFECT OF DIFFERENT NUTRIENT SOLUTIONS ON GROWTH OF LETTUCE IN HYDROPONICS (*LACTUCA SATIVA* L.)

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(Date of Receiving-14-11-2025; Revision-18-12-2025; Date of Acceptance-01-02-2026)

ABSTRACT

This study explores the use of organic liquid fertilizers in a Nutrient Film Technique (NFT) hydroponic system for growing lettuce (*Lactuca sativa* L. var "Locarno"). It compares the performance of organic fertilizers panchagavya, jeevamrutham and vermi wash against conventional chemical fertilizers in terms of plant growth, yield, and quality. Conducted at Malla Reddy University, Hyderabad, during the 2023-24 academic year, the experiment involved seven treatments with varying nutrient concentrations such as T_1 - Hydroponic Sol A and B (Control), T_2 – Panchagavya, T_3 – Jeevamrutham, T_4 – Vermiwash, T_5 - SOL A and B (50%) + Panchagavya, T_6 - SOL A and B (50%) + Jeevamrutham and T_7 - SOL A and B (50%) + Vermiwash. These were tested at different intervals on lettuce plant growth parameters such as plant height, leaf width, and canopy diameter were measured. Treatment (T_1) solutions A and B produced with higher plant growth parameters such as lengthy plants (13.70 cm), longer leaf blade (9.38 cm), broader leaves (9.98 cm), wider canopy (23.82 cm), more number of leaves (18.90), root length and volume (18.96 cm, 8.60 ml) along with plant survival rate and crop duration (39.66 % and 25 days).

Key words: Hydroponics, Nutrient solutions, Solution A and B, Vermiwash, Jeevamrutham, Panchagavya

Introduction

In this paper Soilless cultivation methods like hydroponics, aeroponics, and aquaponics use mineral nutrient solutions or inert media (e.g., coco peat, gravel) instead of soil to grow plants. These methods optimize resource use, reduce malnutrition, and combat climate challenges. Hydroponics, in particular, enhances plant growth by providing the necessary nutrients through water. It is widely used for growing vegetables such as lettuce (Lactuca sativa), a nutritious, low-calorie crop rich in minerals, fiber, and bioactive compounds. Hydroponics offers several benefits, including year-round productivity, reduced water usage, and minimal environmental stress.

This study focuses on the impact of organic fertilizers, such as panchagavya, jeevamrutham, and vermiwash, on lettuce growth in a Nutrient Film Technique (NFT) hydroponic system. Organic fertilizers, derived from natural plant and animal sources, offer essential nutrients and growth hormones for plant development. Objectives of the study include examining growth parameters in hydroponics using organic versus conventional fertilizers in lettuce production. The findings aim to improve hydroponic practices and enhance crop growth.

Materials and Methods

The hydroponics experiment entitled "Studies on hydroponic cultivation using different nutrient solutions in lettuce (Lactuca sativa L.)" was conducted during February 2023–2024 at Malla Reddy University, Hyderabad, Telangana, India, using the Nutrient Film Technique (NFT) inside a fan-and-pad polyho use. Lettuce seedlings of the variety 'Locarno' were raised in cocopeat-filled pro trays and transplanted into the NFT system at 14–16 days after sowing. The experiment comprised seven nutrient solution treatments, including a commercial hydroponic nutrient solution (Solution A and B at 10 ml + 10 ml L^{-1} water) as control, organic liquid fertilizers-Panchagavya (40 ml L^{-1}), Jeevamrutham (40 ml L^{-1}) and Vermiwash (20 ml L^{-1})- and their combinations with 50% strength Solution A and B. Nutrient solutions were freshly prepared and supplied continuously through the NFT system. Observations on growth and development were recorded at 7, 14, and 25 days after transplanting (DAT) from randomly selected plants. Parameters studied included plant height, plant spread (canopy diameter), leaf length, leaf width, number of leaves per plant, root length, root volume, plant survival percentage, and crop duration. Plant height was measured from the base to the tip of the longest leaf, while canopy diameter was recorded in two perpendicular directions. Leaf length and width were measured from the largest fully expanded leaf. Root length and root volume were recorded at harvest, with root volume determined using the water displacement method. Plant survival percentage and crop duration were calculated at harvest maturity. Throughout the experimental period, nutrient solution pH and electrical conductivity (EC) were monitored regularly, and the pH was maintained within the optimum range of 5.5–6.5 to ensure favorable growing conditions.

Result and Discussion

The research entitled "Studies on Hydroponic Cultivation Using Different Nutrient Solutions in Lettuce (*Lactuca sativa* L.)" conducted, explored the effect of various nutrient solutions on the growth of lettuce in a nutrient film technique hydroponic system. Results showed significant variations in growth and yield. Lettuce grown with hydroponic solutions A and B (T_1) exhibited better growth, including broader leaves, longer leaf blades, a wider canopy, and more leaves, followed by solution A and B 50% + vermiwash (T_7) and vermiwash (T_4). The poorest growth was observed with Panchagavya (T_2) and Jeevamrutham (T_3), showing shorter plants, narrower leaves, and fewer leaves. Other treatments like solution A and B 50% + Panchagavya (T_5) and solution A and B 50% + Jeevamrutham (T_6) showed moderate results. The study also found that synthetic commercial nutrient solutions resulted in higher root volume, while organic solutions led to poorer growth.

Plant height (cm) and spread diameter (cm)

Plant height and spread diameter are key indicators of plant growth, reflecting the plant's ability to synthesize and accumulate organic matter. Measurements were taken from five plants at 7, 14, and 25 days after transplanting using a standard ruler. At all growth stages, the tallest plants and widest spreads were observed in treatment (T_1) with solution A and solution B, with values of 9.69, 13.66, 13.70 cm for height and 11.59, 16.70, 23.82 cm for spread. Treatment (T_7), using solution A and B with 50% vermiwash, showed similar growth (8.97, 13.15, 13.30 cm for height and 10.95, 15.80, 22.43 cm for spread). Treatment (T_4), with vermiwash, resulted in moderate growth (8.85, 10.99, 10.99 cm for height and 10.79, 14.27, 14.73 cm for spread). The lowest growth was observed in treatment (T_2) with panchagavya (6.36, 6.60, 6.96 cm for height and 8.53, 8.63, 10.83 cm for spread).

The study highlights that hydroponic nutrient solutions A and B led to better plant growth than organic fertilizers. These solutions positively influence plant height and canopy diameter by providing essential nutrients like nitrogen, potassium, and calcium. Adequate nitrogen supports vegetative growth, while potassium helps with water balance and nutrient absorption, leading to taller and wider plants. The optimum growth observed was linked to the availability of higher amounts of inorganic nutrients.

Various studies indicate that nutrient compositions tailored to specific growth stages, combined with appropriate environmental conditions, can lead to significant improvements in lettuce canopy size and overall yield, (Solis, 2022). Application of both 30% and 40% vermiwash has been reported to significantly increase the plant height of lettuce. These concentrations show remarkable effectiveness in promoting the growth characteristics of lettuce, including height (El-Akkad, 2024).

Leaf length (cm) and Leaf width (cm)

The application of different nutrient solutions significantly influenced the leaf length and width of lettuce at 7, 14, and 25 days after transplanting. The highest leaf length (7.95, 9.32, 9.38 cm) and leaf width (5.95, 9.62, 9.98 cm) were observed in treatment (T_1) with solutions A and B, followed by treatment (T_7) with solution A and B 50% + vermiwash (7.74, 8.79, 8.97 cm for leaf length and 5.89, 8.95, 9.12 cm for leaf width). Treatment (T_4) with vermiwash showed moderate growth (6.86, 8.46, 8.77 cm for leaf length and 5.60, 7.64, 7.96 cm for leaf width). The lowest values were recorded in treatment (T_2) with panchagavya (5.40, 5.54, 5.68 cm for leaf length and 3.53, 4.55, 5.29 cm for leaf width).

The data indicates that conventional hydroponic nutrient solutions result in the highest leaf growth, outperforming organic fertilizers. GA3 plays a key role in promoting leaf area by encouraging cell elongation, and nitrogen supports the growth of healthy leaves and stems.

The composition of hydroponic solutions, particularly nitrogen, potassium, and calcium, is crucial in determining lettuce leaf size. Lettuce leaf length and width in hydroponic systems are significantly affected by nutrient composition, pH, environmental conditions, temperature, system type, and water flow rates. Proper management of these factors can enhance leaf growth (Chowdhury, 2024).

Number of leaves per plant

Significant variation was observed in the number of leaves per lettuce plant using different nutrient solutions. The highest leaf count was recorded in treatment (T_1) with solution A and B, yielding values of 5.90, 8.13, and 18.90 leaves, followed by treatment (T_7) with solution A and B 50% + vermiwash (5.74, 7.36, and 18.67 leaves), and (T_4) vermiwash (5.76, 7.73, and 10.16 leaves). The lowest count was found in treatment (T_2) with panchagavya (5.23, 6.26, and 8.83 leaves).

The results highlight that liquid synthetic fertilizers in an NFT hydroponic system led to the highest leaf production compared to organic fertilizers, likely due to the direct availability of essential nutrients in inorganic form to the plant roots. Nitrogen, particularly in the form of nitrate or ammonium, promotes vegetative growth and increases leaf count. Additionally, cytokinins, a class of plant growth regulators, accelerate leaf growth and cell division, contributing to more leaves. Commercial hydroponic fertilizers may also include synthetic cytokinins.

A study found that lettuce plants grown with optimized nutrient solutions had a higher leaf count than those grown with standard or unbalanced formulations, indicating that fine-tuning nutrient ingredients can significantly enhance leaf growth in hydroponic systems (Gong, 2024).

Root length (cm) and root volume (ml)

Lettuce root length and volume showed significant differences when treated with various nutrient solutions in the NFT hydroponic system, measured at 7, 14, and 25 days after transplanting. The highest root length (16.85, 17.97, 18.96 cm) and volume (2.29, 5.96, 8.60 ml) were recorded with (T_1) solution A and B, followed by (T_7) solution A and B 50% + vermiwash (16.77, 17.89, 18.89 cm and 1.93, 5.57, 8.11 ml). Treatment (T_4) vermiwash showed moderate results (15.86, 16.98, 18.56 cm and 1.86, 5.55, 7.30 ml), while the lowest values were found with (T_2) panchagavya (13.66, 13.82, 15.76 cm and 1.26, 1.76, 5.43 ml).

The results suggest that synthetic commercial nutrient solutions promote better root growth than organic solutions. Vermiwash enriches the nutrient solution with essential nutrients, beneficial microorganisms, and growth hormones, enhancing root development. Chemical solutions encourage longer roots due to optimal nutrient availability, while organic solutions may be less effective due to nutrient variability and potential pathogen risks (Bottoms *et al.*, 2012).

Survival (%) and Crop duration (days)

Different nutrient solutions significantly affected lettuce crop survival and duration at 25 DAT. The

Table 1: Effect of different nutrient solutions on Plant height (cm), Spread diameter (cm), leaf length (cm) and width (cm).

Treatments	Plant height (cm)	Spread Diameter (cm)	Leaf length (cm)	Leaf width (cm)
T_1 - Hydroponic Sol A and B (Control) – 10 +10 ml / 1 lit water	13.70	23.82	9.38	9.98
T_2 - Panchagavya - 40 ml / 1 lit water	6.96	10.83	5.68	5.29
T_3 - Jeevamrutham - 40 ml / 1 lit water	9.02	10.86	5.98	5.67
T_4 - Vermiwash- 20 ml / 1 lit water	10.99	14.73	8.77	7.96
T_5 - SOL A and B (50%) + Panchagavya - 40 ml/ 1 lit water	10.03	15.40	7.36	6.68
T_6 - SOL A and B (50%) + Jeevamrutham - 40 ml/ 1 lit water	9.29	13.00	6.89	6.94
T_7 - SOL A and B (50%) + Vermiwash - 20 ml/ 1 lit water	13.30	22.43	8.97	9.12
SEm (±)	0.13	0.44	0.02	0.16
CD (p=0.05)	0.40	1.35	0.07	0.50

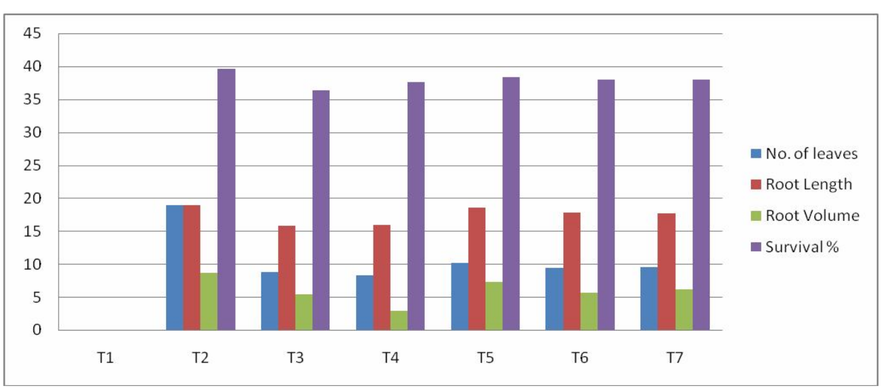

Fig. 1: Effect of different nutrient solutions on Plant height (cm), Spread diameter (cm), leaf length (cm) and width (cm).

Table 2: Effect of different nutrient solutions on no. of leaves, Root length(cm), Root volume(%) and Crop duration(days).

Treatments	No. of leaves	Root Length (cm)	Root Volume (ml)	Survival %	Crop duration (days)
T_1 - Hydroponic Sol A and B (Control) – 10 +10 ml / 1 lit water	18.90	18.96	8.60	39.66	25.00
T_2 - Panchagavya - 40 ml / 1 lit water	8.83	15.76	5.43	36.33	26.50
T_3 - Jeevamrutham - 40 ml / 1 lit water	8.26	15.87	2.83	37.66	26.00
T_4 - Vermiwash- 20 ml / 1 lit water	10.16	18.56	7.30	38.33	25.33
T_5 - SOL A and B (50%) + Panchagavya - 40 ml/ 1 lit water	9.46	17.85	5.63	38.00	25.40
T_6 - SOL A and B (50%) + Jeevamrutham - 40 ml/ 1 lit water	9.50	17.66	6.20	38.00	26.33
T_7 - SOL A and B (50%) + Vermiwash - 20 ml/ 1 lit water	18.67	18.89	8.11	38.66	25.39
SEm(±)	0.07	0.02	0.16	0.43	0.21
CD (p=0.05)	0.23	0.07	0.49	1.32	0.67

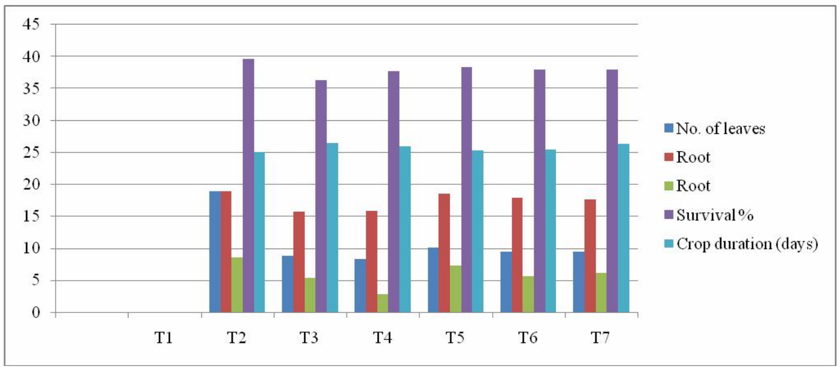

Fig. 2: Effect of different nutrient solutions on no. of leaves, Root length(cm), Root volume(%) and Crop duration(days).

This study assessed the effects of various nutrient solutions on lettuce (*Lactuca sativa* L.) growth and yield in a Nutrient Film Technique (NFT) hydroponic system at Malla Reddy University, Table 1 - Effect of different nutrient solutions on Plant height (cm), Spread diameter (cm), leaf length (cm) and width (cm) Hyderabad, during 2023-24. Seven treatments, including synthetic and organic solutions, were tested.

The results showed that synthetic highest survival rate (39.66%) and shortest duration (25 days) were observed in treatment (T_1) with solutions A and B, followed by (T_7) solution A and B 50% + vermiwash (38.33% survival in 24.39 days) and (T_4) vermiwash (38.66% survival in 25.33 days). The lowest survival rate was recorded in (T_2) panchagavya (36.33%) with a crop duration of 26.50 days.

The results indicate that synthetic nutrient solutions A and B support higher survival rates and shorter crop durations compared to organic fertilizers. Proper nutrient solution management, including a balance of macronutrients (nitrogen, phosphorus, potassium) and micronutrients (iron, calcium, magnesium), is crucial for healthy growth. High nitrogen promotes leafy growth, phosphorus supports root development, and potassium enhances plant health and maturity.

Nutrient imbalances can lead to stress and stunted growth. A balanced nutrient supply ensures better growth and resilience (Majid *et al.*, 2021). A study also found that organic fertilizers like 'Espartan' can improve lettuce growth and maturation rates (Chowdhury *et al.*, 2024).

nutrient solutions (T_1) with solutions A and B and the combination of (T_7) solutions A and B 50% + vermiwash performed best in terms of growth, yield, and quality.

Summary and conclusion

These treatments led to superior plant growth compared to organic solutions like Panchagavya (T_2). The study suggests that combining synthetic solutions with vermiwash can enhance hydroponic lettuce production. Future work could explore organic solutions, different hydroponic systems, and consumer preferences for organic hydroponic produce. These treatments led to superior plant growth compared to organic solutions like Panchagavya (T_2). The study suggests that combining synthetic solutions with vermiwash can enhance hydroponic lettuce production. Future work could explore organic solutions, different hydroponic systems, and consumer preferences for organic hydroponic produce.

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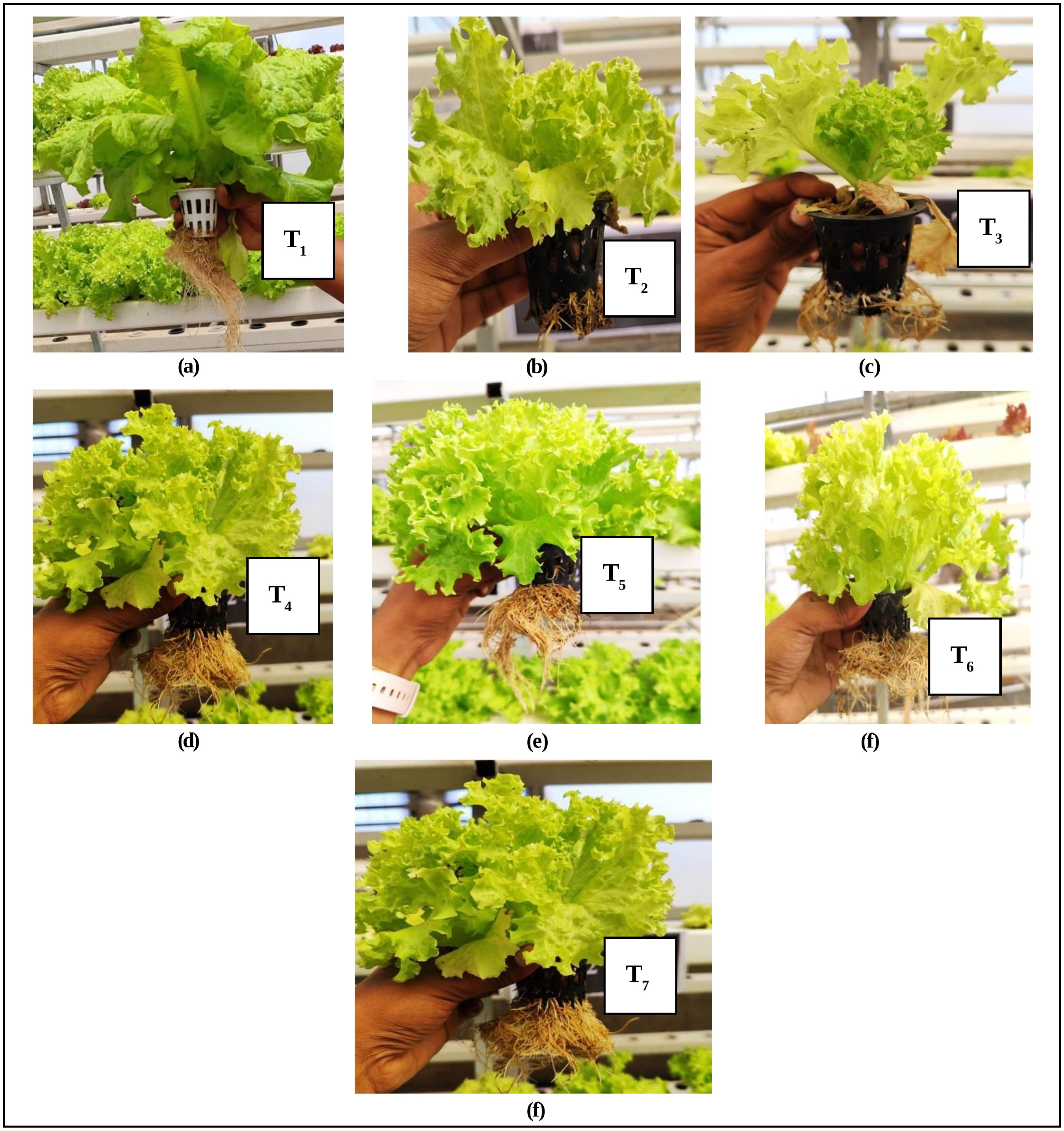

Plate 1: Treatments grown lettuce var (Locarno) using different nutrient solutions in NFT hydroponic system. (a) T_1 (Control) Sol A &B , (b) T_2 Panchagavya, (c) T_3Jeevamrutham, (d) T_4Vermiwash, (e) T_5 Sol A & B 50% + Panchagavya, (f) T_6 Sol A & B 50% +Jeevamrutham, (g) T_7Sol A & B 50% +Vermiwash.

TSCI.47.12.1768

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