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Use of Low Cost Hydroponics Technique for Growing Coriander at Laboratory Conditions

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ABSTRACT

The experiment on low cost hydroponics for growing coriander at laboratory conditions for increasing production per unit area economically. Low cost hydroponics system is the new scientific techniques of growing plants passively without providing mechanical circulations and artificial aerations around the zone of roots. The type of passive technique followed here is modified Kartky system. To illustrate, the experiment was laid down in Completely Randomized Design with five different types of hydroponic nutrient solutions namely: T_1 (NPK- 15:15:15 + 1% Calcium Nitrate + 1% Magnesium Sulfate), T_2 (NPK – 15:15:15 + 0.5% Calcium Nitrate + 0.5% Magnesium Sulfate), T_3 (NPK- 20:20:20 +1% Calcium Nitrate + 1% Magnesium Sulfate), T_4 (NPK- 20:20:20 + 0.5% Calcium Nitrate + 0.5% Magnesium Sulfate), T_5 (Water). These five independent treatments had 4 replications each. Furthermore, 30% buffered and sterilized coco peat was filled along with seeds on each hydroponics cup. Accordingly, the major observations were taken on 10, 20 & 30 Days after sowing on the basis of specific parameters such as: number of leaves, length of leaves, number of rootlets, length of rootlets, total length of the seedlings and chlorophyll content. To summarize in the end, it was concluded that T_2 (NPK- 15:15:15+ 0.5% calcium nitrate + 0.5 % magnesium sulfate) reported to be the best nutrient treatment solutions with higher germination rate, good root architecture, higher chlorophyll content and other parameters.

Key words: *Low cost, Modified Kratky, Coco peat, Laboratory conditions, Coriander.*

Introduction

Coriander is the first inestimable seed spices anciently used by mankind since 5000 BC. The Egyptians called this herb as "spice of happiness" due to its property of aphrodisiac (Nadeem *et al*., 2013). The "coriander" name acquired by Pliny, it is procured from word "Koros" a greek origin meaning "bedbug" resembling the fetid smell of the leaves. Moreover, the leaves and fruits of coriander are gifted with ample of nutrients (Nimish *et al*., 2011; Bhat *et al*., 2014). In addition, coriander leaves and fruits are used for culinary and drug by European pharmacopoeias since antiquity (Nikhat *et al*., 2012).

In 1929, the name "hydroponics" was coined first by Willam. F. Gericke, (1929) a scientist and professor in California University. He perpetrated a research trail on growing plants in lab oratorical conditions with the suspension of roots in water containing mineral nutrient and promoted its use commercially. Thereafter successive works and development have taken place in this field. In 2004, a researcher named Kratky (2004) executed a study on pot suspension over non- circulating hydroponics method which to certain extent again shifted the focus towards low cost hydroponic techniques. In this

method plants are grown in a passive process by placing the plant roots in a liquid nutrient rich solution or moist inert materials despite of soil, oxygen pumps and nutrient circulation system. This technique being budget friendly can be easily adopted by marginal farmers. This soilless media uses cocopeat, perlite, vermiculite, brick shards and polystyrene packing peanuts as growing media (Sharma *et al*., 2018). Low-cost hydroponics is a cost-effective cultivation which is pesticides free, disease free, ecofriendly and gaining popularity all over the world.

The population of human race escalated with the urbanization and globalization. This utterly indicates the gap between the demand and supply for food and conventional techniques are not sufficient enough to meet the needs. As a result, low- cost hydroponics techniques are the most auspicious alternative asset which will invade sustainably to achieve quality food faster without breaching the conduct of national food security. Thus, in the present study low cost hydroponic technique was used to grow coriander in laboratory condition using a Kratky system (modified) of non circulating hydroponic method.

Materials and Method

The seeds of coriander (*Coriandrum sativum* L.) of variety RAMSES of East West Seed International, were procured from Baithakkhana Bazar, Vidyapati Setu, Sealdah, West Bengal 700 009. The research work was carried out in the laboratory of Department of Horticulture, Institute of Agricultural Science, University of Calcutta in academic year of 2021-2022. The type of passive hydroponic technique followed here is modification of Kratky method. For this to achieve a cotton wick was attached underneath the coco-peat acting as a junction between the planting media and nutrient solutions to facilitates speedy nutrient flow at the root zone and require neither electricity and pumps nor oxygen and nutrient circulating system. Initially, it facilitates capillary action techniques to the seeds and deep-rooted techniques in the later stages for the availability of the nutrient solutions to the seedlings in precision manner. In brief, this modified Kratky system being a passive hydroponics system provides ample and adequate nutrients towards seedlings promoting healthy and faster growth in a low budget condition.

Thereafter the coco peat was processed (SMgardner, 2020; SMgardner, 2021; Jing and Greens PH, 2021). A sufficient amount of loose coco peat was taken and washed thoroughly to discard its high salt concentrations by deionized water having TDS -65 ppm, repeatedly until the Total Dissolve Solids of coco-peat extract reaches below 250 ppm or approx. Thereafter the washed coco- peat is squeezed using a mesh cloth and spread under the sun for drying. Next, the dried coco- peat was buffered with the solutions of calcium nitrate (7 g ml^{-1}) and kept in container for 48 hours. Thereafter, again the coco peat is washed thoroughly with distilled water and squeezed until the TDS of the buffered coco-peat extract reaches nearby 250 ppm or below and dried again. Lastly, the buffered coco-peat is sterilized with 3% hydrogen peroxide (10ml l^{-1} in distil water) and cover with aluminum foil for 2hrs followed by squeezing and drying. Finally, the seeds are presoaked in distill waters for 24 hrs and then 12 seeds are sown at depth of 7- 10mm in 35% of planting materials in each hydroponic cup thereby.

The experimental treatments as nutrient solution that were employed in this research trial were as a follows: T_1- NPK- 15:15:15 + 1% Calcium Nitrate + 1% Magnesium Sulfate;T_2- NPK – 15: 15: 15 + 0.5 % Calcium Nitrate + 0.5% Magnesium sulfate; T_3- NPK – 20: 20: 20 + 1% Calcium Nitrate + 1% Magnesium Sulfate;T_4- NPK – 20: 20:20 + 0.5% Calcium Nitrate + 0.5% Magnesium Sulfate; T_5- Water (Control). The observations were taken at 10, 20 and 30 days after sowing. Parameters which were taken into account for the study were numbers of leaves (Chaulagain *et al*., 2011), length of the leaves (Draie, 2019), length of the roots (Alatorre-Cobos *et al*., 2014), number of rootlets (Dual *et al*., 2019), total length of seedlings (Dual *et al*., 2019) and total chlorophyll content (Ranganna, 2003). All the five treatments were replicated four times with Completely Randomized Design (Gomez and Gomez, 1984). Help of online software was taken for statistical analysis (Sheoran *et al*., 1998).

Every day the hydroponic cups were exposed under the artificial illumination for 12 hrs. respectively. Moreover, the solutions of respective treatments were changed after every 6 days.

Results and Discussion

Total number of leaves

Astounding difference among the treatment was

recorded due to different nutrient concentration in hydroponics. Number of leaves per plant is an important factor for accumulating carbohydrates through photosynthesis. The number of leaves in each installment was recorded. The highest and lowest number of leaves was estimated on the basis of total leave per plant/ replicate. It had been revealed from experiment results for 10 DAS presented in Table 1 that the collected highest number of leaves was 2 and it was same among all the treatments (T1, T2, T3, T4 and T5). Next leave counting was done on 20 days and according to which the highest number of leaves was again 2 observed same in all the treatments (T1, T2, T3, T4, and T5). Last reading was recorded on 30 DAS, the maximum number of leaves was 3.0 observed in T2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) followed by T1 (NPK-15:15:15 +1% calcium nitrate + 1% magnesium sulfate) with 2.83 number of leaves and the minimum number of leaves was observed in T3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate) where the number of leaves were recorded as 2.17.

Table 1. Total number of leaves of the coriander seedlings (cm) as developed from low cost hydroponics system.

Treatments	10 DAS	20 DAS	30 DAS
T1	2	2	2.83
T2	2	2	3.00
T3	2	2	2.17
T4	2	2	2.33
T5	2	2	2.67
CD at 5%	-	-	0.424
SEM±	-	-	0.139

Length of the leaves

Differences were inscribed in case of the length of leaves under different nutrient concentration as treatments in hydroponics as shown in Table 2. As usual the first reading was taken on 10 DAS which showed a highest leaf length of 11.50 cm in the treatment of T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) and the lowest leaf length of 5.51cm in the treatment of T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate). In the next observation on 20DAS, the maximum leaf length of 16.00cm in the treatment of T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) and a minimum leaf length of 7.75 cm in the treatment of

Table 2. Length of leaves of the coriander seedlings (cm) as developed from low cost hydroponics system.

Treatments	10DAS	20DAS	30DAS
T_1	7.08	12.50	15.35
T_2	11.50	16.00	15.47
T_3	5.51	7.75	10.14
T_4	6.97	13.50	13.50
T_5	9.00	14.93	17.62
CD at 5%	1.008	1.391	2.300
SEM±	**0.331**	**0.457**	**0.756**

T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate) while at last observation observed it showed a maximum leaf length of 17.62 cm in the treatment of T_5(control)while minimum leaf length of 10.14cm in the treatment of T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate). However, the other treatments viz. T_1 (NPK-15:15:15 +1% Calcium nitrate +1% magnesium sulfate), T_2 (NPK-15:15:15 + 0.5% calcium nitrate + 0.5 % magnesium sulfate) and T_4 (NPK- 20:20:20 + 0.5% Calcium nitrate + 0.5% magnesium sulfate) recorded & standard mean length of leaves between 13- 16cm.

Length of the roots

The major scrutinization was done on 10, 20 and 30 DAS for measuring the roots of seedling. The random seedlings were selected and roots were measured from the tip of the primary root to the base of the hypocotyls. It is being detected from the experimental results shown in Table 3, that highest root length of 14.83 cm in the treatment T_4 (NPK-20:20:20 + 0.5 % calcium nitrate + 0.5% magnesium sulfate) and lowest root length of 8.00 cm was observed in the treatment of T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate) on 10 DAS. In the next observation the maximum root length of 34.50

Table 3. Length of the roots of the coriander seedlings (cm) as developed from the low cost hydroponics system.

Treatments	10 DAS	20 DAS	30 DAS
T_1	11.25	34.50	42.97
T_2	12.83	25.33	37.17
T_3	8.00	15.05	21.08
T_4	14.83	25.67	37.00
T_5	10.00	16.33	22.17
CD at 5%	1.653	1.499	1.387
SEM±	0.543	0.493	0.456

cm in the treatment of T_1 (NPK-15:15:15+ 1 % calcium nitrate + 1 % magnesium sulfate) which was followed by T_4 (NPK- 20:20:20 + 0.5 % calcium nitrate + 0.5% magnesium sulfate) showing a length of 25.67cm, whereas the lowest root length was 15.05 cm observed in T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate) on 20 DAS. Thereafter at the last observation the highest root length, 42.97 cm was observed in T_1 (NPK-15:15:15+ 1 % calcium nitrate + 1 % magnesium sulfate) followed by T_2 (NPK-15:15:15 + 0.5% calcium nitrate + 0.5% magnesium sulfate)showing a length of 37.17cm and 37 cm for T_4 (NPK-20:20:20 +0.5% calcium nitrate +0.5% magnesium sulfate). Whereas the lowest, 21.08 cm was observed in T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate).

Number of the rootlets

Remarkable distinctness in rootlet numbers were perceived in case of different replications for different treatments. It is noticeable from Table 4 that the highest number of rootlets was 1 and which observed same for all the treatments (T_1, T_2, T_3, T_4 and T_5) on 10 DAS. For the next observation on 20 DAS, the number of rootlets increased as compared to the initial day. The highest number of rootlets of 2.83 was observed in T_4 (NPK-20:20:20 + 0.5 % calcium nitrate + 0.5% magnesium sulfate) which was closely followed by T_2 (NPK -15:15:15 + 0.5% calcium nitrate + 0.5% magnesium nitrate) with 2.67 number of rootlets and the lowest number of rootlets of 1.50 was observed in T_5 (control). In the last observation of 30DAS the trend in increase in the number of rootlets continued and the number of rootlets was observed as 2.83 in T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) which was jointly followed T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate) and T_4 (NPK-20:20:20 + 0.5% calcium nitrate + 0.5% magnesium sulfate) showing 2.67 number of rootlets and the least value was observed in T_5 (control).

Total length of the seedlings

Seedlings were selected randomly for final length measurement. The total length of seedlings was obtained by adding root and shoot length. The root and shoot length were measured from the tip of the primary root to the base of hypostyle and from the tip of the primary leaves to the base of hypostyle respectively. Table 5 on 10 DAS perceived the highest seedling length of 76.50 cm in treatment T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) which was closely followed by T_4 (NPK-20:20:20 + 0.5% calcium nitrate + 0.5% magnesium sulfate)showing a seedling length of 72.5cm. Then the lowest seedling length 52.50 cm in treatment was observed in treatment in T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate). For the next reading the maximum total length of seedling, 108.67 cm was observed in T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) and the lowest length of seedling, 67.73 cm was observed in T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate)on 20 DAS. Lastly on 30DAS the highest length of seedling was 148.50 cm which was observed in T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate). The next best treatment had a good amount of difference from it, as T_4 (NPK- 15:15:15 +0.5 % calcium nitrate + 0.5% magnesium sulfate) succeeded T_2 (NPK-15:15:15 + 0.5% calcium nitrate +0.5% magnesium sulfate), documenting a length value of 123 cm. while the lowest length of the seedling, 87.92cm was observed in T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate) on 30 DAS.

Total Chlorophyll content

The highest total chlorophyll content for 10 DAS

Table 4. Number of rootlets of the coriander seedlings (cm) as developed from low cost hydroponics system.

Treatments	10 DAS	20DAS	30 DAS
T_1	1	2.00	2.50
T_2	1	2.67	2.83
T_3	1	2.00	2.67
T_4	1	2.83	2.67
T_5	1	1.50	2.00
CD at 5%	-	0.863	0.555
SEM±	-	0.284	0.183

Table 5. Total length of the coriander seedlings (cm) as developed from low cost hydroponics system.

Treatments	10 DAS	20 DAS	30 DAS
T_1	64.08	97.83	119.30
T_2	76.50	108.67	148.50
T_3	52.50	67.73	87.92
T_4	72.50	88.67	123.00
T_5	57.58	68.50	93.17
CD at 5%	3.670	2.602	3.411
SEM±	1.206	0.856	1.121

(Table 6) was 0.142 (mg/ml) observed in T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) while the lowest total chlorophyll content was 0.073 (mg/ml) observed in T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate). Next, the highest total chlorophyll content for 20 DAS was measured 0.138 (mg/ml) in treatment T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) which was very nearly succeeded by T_1 (NPK- 15:15:15+ 1% calcium nitrate + 1% magnesium sulfate) showing 0.134(mg/ml) and while the lowest total chlorophyll content was 0.089 (mg/ml) observed in T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate). Lastly for 30 DAS maximum total chlorophyll content was measured as 0.218 (mg/ml) in the treatment T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) and T_1 (NPK-15:15:15 +1% calcium nitrate + 1% magnesium sulfate) showing the next best treatment with chlorophyll accumulation of 0.190 (mg/ml) and the lowest total chlorophyll content was 0.129 (mg/ml) observed in T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate) for 30 DAS.

In this research trail, it has been perceived that low cost hydroponics is budget friendly system which aims in providing nutrient solution at the root zone of the seedlings in the hydroponic cups by the help of modified Kratky, employing neither electricity and pumps nor oxygen and nutrient circulating system. The data suggest astounding benefits on the number of leaves and length of the leaves (Table 1 and Table 2) etc. The parameter of number of cotyledonary leaves were same until week 4, but after the fortnight new flushes arrived from the junction of the two petioles. As the days count move forward towards week 3, the maximum number of leaves was observed of 3 in treatment T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate). These new flushes are cilantro which becomes more prominent after 25 days. All the treatments also showed increased in the length of leaves. At the end of the experiment significantly proper leaf length was observed among the various treatments. Similarly relevant results were detected in an earlier work (Maboko and Du Plooy, 2009) where leaf area and number of leaves count increased with significantly higher in lettuce grown hydroponically.

The data analysis also revealed appreciable effects in length of roots and number of rootlets counts in the coriander seedlings in (Table 3 and 4). The data suggest in table 3 that number of rootlets per seedlings was increased with increasing in days. Overall highest number of rootlets, 2.83 was recorded in T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) on 30 DAS, whereas the count of rootlets was same in case of all treatment (T_1, T_2, T_3, T_4 and T_5) on 10 DAS. Moreover, for (Table 3) root length it was observed highest of 42.97 cm in treatment T_1 (NPK-15:15:15+ 1 % calcium nitrate + 1 % magnesium sulfate) on 30 DAS while the lowest root length was observed of 21.08cm in the treatment of T_3 (NPK-20:20:20 + 1% calcium nitrate + 1% magnesium sulfate). In additions, initially the seeds received nutrients with the help of cotton wick for faster growth. However, in the later stage the expansion of taproot and lateral roots takes place along the growth of the overall seedlings. The roots after reaching the container bottom gets direct supply of nutrients from the nutrient solutions while few lateral roots suspended freely in the air for sufficient oxygen intake in between the nutrient solutions and hydroponic cup. To summarize, growing seedlings on non- circulating hydroponic platform interprets rapid induction in growth of taproot and lateral root strands and ultimately increasing the length and number of rootlets. Similar experimental studies have been done previously (Chen *et al.*, 2011) which reported that a semi-hydroponic bin system was developed to provide an efficient phenotypic platform for permitting mapping and digital measurement of dynamic growth of taproot and lateral roots along with deep root system.

Furthermore, there is a substantial increase in overall total length of seedlings, as the data suggest (Table 5) that maximum total length of seedlings was observed of 148.50 cm in the treatment in T_2 (NPK-15:15:15+ 0.5 % calcium nitrate + 0.5% magnesium sulfate) whereas the lowest total length of seedlings was observed as 123 cm in the treatment

Table 6. Total Chlorophyll content (mg/ml) of the coriander seedlings as developed from low-cost hydroponics system.

Treatments	10 DAS	20 DAS	30 DAS
T_1	0.083	0.134	0.190
T_2	0.142	0.138	0.218
T_3	0.073	0.089	0.129
T_4	0.111	0.122	0.165
T_5	0.115	0.126	0.135
CD at 5%	0.010	0.003	0.016
SEm±	0.003	0.001	0.005

T_4 (NPK-20:20:20 + 0.5% calcium nitrate + 0.5% magnesium sulfate). The modified Kratky system facilitates precise and adequate supply of nutrients at the root zone in the coco peat media which holds a high temperature, high water holding capacity with good aerations. Thus, it provides ample opportunities towards healthy growth of the seedlings. For instance, similar observations were observed by scientists (Swain *et al*., 2021; Reshma and Joseph, 2017) where coco peat was found best growing media in a hydroponic unit facilitating high growth rate of tomato seedlings and indoor grown vegetables.

Comparatively at the same time, 12-hour illumination system played a crucial role in increasing the chlorophyll content. The data analysis in (Table 6) identifies that chlorophyll content increased throughout the experiment and the last day reading the total chlorophyll content was found to be maximum for T_2 (NPK-15:15:15 + 0.5% calcium nitrate +0.5% magnesium sulphate) showing value of 0.218 mg/ml. Thus, the data found in this research trail support a practical observation (Um *et al*., 2010) **w**here the chlorophyll content increases in the seedlings, when the seedlings were exposed to same light intensity period uniformly every day. However, results may vary with different types of illuminating system.

Conclusion

Low-cost hydroponics is a non- circulating passive technique which is budget friendly in nature. The technique used here is modified Kratky system. The germination rate was higher than the traditional system. The maximum number of leaves was observed on 30 DAS of 3.0 in the treatment T_2 (NPK-15:15:15 +0.5% Calcium Nitrate+ 0.5% Magnesium Sulfate). A highest length of leaves was observed of 17.62 cm in T_5 (control). The highest well defined root length was observed of 42.97 cm in the treatment T_1 (NPK-15:15:15 + 1% calcium nitrate + 1% Magnesium sulfate). The maximum rootlets were observed of 2.83 in the treatment T_2 (NPK- 15:15:15 + 0.5% Calcium Nitrate + 0.5% magnesium sulfate). Also, the highest length of total seedling and the maximum total chlorophyll accumulation was observed in the treatment T_2 (NPK- 15:15:15+ 0.5% calcium Nitrate + 0.5% magnesium Sulfate). Thus, it can be concluded from the research work that the low- cost hydroponics techniques results in maximum production per unit area in a very short time. Maximum progress was observed in the seedlings of T_2 (NPK-15:15:15+ 0.5% Calcium Nitrate + 0.5% Magnesium sulfate) with respect to various parameters.

Conflict of Interest: There is no conflict of interest.

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