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EFFECT OF DIFFERENT NUTRIENT SOLUTIONS ON ROOTING OF *Acmella calva* (DC.) R. K. JANSEN IN HYDROPONIC SYSTEM

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ABSTRACT

Experiment was conducted to evaluate the important medicinal plant *Acmella calva* (DC.) R.K. Jansen for the rooting ability of shoots treated with Indole-3-butyric acid (IBA) using hydroponic system at Green House Centre, Herbal Garden, PG and Research Department of Botany, Holy Cross College (autonomous), Tiruchirappalli-02, Tamil Nadu, India, during the year 2020. The IBA treated shoots were cultured in different concentrations of MS medium and modified Hoagland medium for rooting. A maximum of 100% response was in 1/6, 1/8, 1/10 strength of MS medium and 1/2 strength of modified Hoagland medium. Number of roots were many (16 roots/shoot) in 1/10 strength of MS medium, and 1/2 modified Hoagland medium. An average length of 3.2 cm (1/10 strength of MS medium) and 3.0 cm (1/2 modified Hoagland medium) were identified. Hence, this is the first evident report on successful optimal growth condition developed through hydroponic system (soilless nutrient condition) for the growth of an important medicinal herb *Acmella calva* (DC.) R.K. Jansen. The report proves as an alternative system of growth of traditional medicinal plant in hydroponics, which ultimately aids in conservation of the plant at low cost and less time. Eventually the study also provides an effective reproducible method of farming to encounter the downsides of farmers and uplift their economic status in the country.

(Key words: *Acmella calva*, hydroponic, IBA treatment, MS medium, modified Hoagland medium, rooting)

INTRODUCTION

In India, agriculture sector has been considered as the back bone of the country and plays vital role in the livelihood of farmers even throughout the world. Farmers typically utilize cultivable land as growing media to develop their agricultural products, fronting several threats due to urbanisation, climate change and high cost of fertilizers and pesticides. The plants grown with high use of pesticides create several health problems to the consumers leading to various diseases and disorders. This has to be considered as a major obstacle that must be solved and need to develop an alternative method to assist farmers to get a high yield of disease-free crop. The hydroponic technology is a suitable and conventional method adopted for the cultivation of crops in the soilless media. This system involves simple growing method, where water is used as a substrate supplemented with essential nutrients. This technique involves no need for heavy machinery and man power, also weeds and diseases can be controlled without spraying chemicals. In recent years, this technique has been created a great impact in the agriculture technology to accomplish modern farming on a large scale to elevate the socioeconomic status of farmers in the country (Prayoga and Putra, 2020).

The herb *Acmella calva* (DC.) R.K. Jansen is a rare medicinal plant belongs to the family Asteraceae. The decoction of the root is used as a laxative. The plant parts are used for toothache, throat problems and paralysis of the tongue, rash, dysentery and rheumatism. The leaf decoction was used as both in rheumatism or as a long for scabies and psoriasis (Kurian, 2007). Leaves are chewed to relieve toothache and infections of throat and gums. Tincture made from flower head was reported as a substitute for tincture of pyrethrum to treat inflammation of jaw-bones and caries. The extract of fresh flower tops is effective against anopheles mosquito larvae. It increases the flow of saliva and is useful in fever especially during summer (Prajapati *et al.,* 2003). Hydroponics offers an opportunity to provide optimal conditions for plant growth with higher yields as compared to open field condition for conservation of this valuable medicinal plant. Hydroponic technique can be used anywhere in all agro-climatic zones and those plants have higher nutritional value and tastes more than field growing crops (Singh and Singh, 2013).

The two chief merits of the soilless cultivation of plants are, A) much higher crop yields and B) the hydroponics can be used in places where ordinary agriculture or gardening is impossible. Other advantages

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include faster growth combined with relative freedom from soil diseases; consistent crops and the quality of plants are excellent. Plants grown in hydroponics are not inferior to naturally reared ones in point of favour and their vitamin (van Kooten *et al.,* 2004). The cost of production in hydroponics is also less over conventional methods. Therefore, hydroponics system was considered as a potential alternative for rooting of *A. calva*. No report on hydroponics-based rooting of *A. calva* has been reported so far. The present study aims at the rooting ability of economically important medicinal plant *A. calva* through hydroponics.

MATERIALS AND METHODS

Plant material collection

The healthy and uniform size of about 10 cm long shoots of *A. calva* were collected from Herbal Garden of PG and Research Department of Botany, Holy Cross College (Autonomous), Tiruchirappalli, Tamil Nadu and washed in running tap water.

Treatments in hydroponic system

The basal cut ends of shoots were provided dipping treatment for 3 hrs. with the growth regulator IBA solution (2.0 mg l^{-1}). Control was maintained without IBA treatment by using distilled water. The IBA (2.0 mg l^{-1}) treated explants were inserted in the hole made in thermocole sheets (10 mm) and placed in the nutrient solution of test tube. Two experiments were conducted simultaneously. In the first experiment, the cut ends of the planting materials along with the thermocole sheets were dipped to a depth of 1.0 cm and sub-irrigated in 20 ml of nutrient solution containing different strengths such as 1/2, 1/4, 1/6, 1/8 and 1/10 of MS (Murashige and Skoog) medium (without adding vitamins and amino acids) (Murashige and Skoog, 1962). In second experiment, the plants were sub-irrigated in different strengths (1/2, 1/4, 1/6, 1/8 and 1/10) of modified Hoagland medium (Gibeaut *et al.,* 1997). The culture tubes were incubated under room temperature for root initiation. The nutrient solution was replaced at 3 days interval with same concentration for further growth of roots.

Experimental design and data analysis

Each treatment had 10 replicates and the experiment was repeated thrice. Data were recorded as percentage of rooting, number and length of roots after 21 days of culture.

RESULTS AND DISCUSSION

Preliminary rooting studies were carried out for the stem cuttings of *A. calva* by culturing in distilled water (control) and treated with IBA. Rooting was found better in IBA treatment when compared to the control (distilled water without IBA). The roots were initiated after 7 days of treatment.

The 100 % response was observed in the control. The number of roots recorded in IBA (2.0 mg l^{-1}) were 15 / shoot (Table 1) in water. In the beginning, the plants from both the control and IBA treated were green and healthy in appearance. But in later stage, the shoots were dropping and the leaves were found yellowish due to loss of chlorophyll and subsequently it led to the death of plants.

Root initiation of *A. calva* in hydroponics containing both MS medium and modified Hoagland medium were experimented. Before introducing the plants into the media, the cut shoot end of *A. calva* was treated in IBA (2.0 mg l^{-1}). After three days of inoculation, the root initiation was observed in plants in both the medias. The plants in MS medium with the strength of 1/6, 1/8, 1/10 showed 100% response (Fig. 1c, 1d and1e). Whereas, rooting was 100% in 1/2 strength of modified Hoagland medium and 90% response was observed in 1/6 strength.

Regarding number of roots, in 1/10 strength of MS medium 16 roots/shoot were observed and the same number of roots were recorded in 1/2 strength of modified Hoagland medium (Fig.1f). The average length of root was 3.2 cm and 3.0 cm respectively. The response was 20% in ¼ strength MS medium containing only 2 roots/shoot (Fig. 1b). The plants were dark green and healthy in appearance. After 15 days, the root system was well developed. The increase in the number of lateral roots indicate that MS medium and modified Hoagland medium enhanced the formation of lateral roots (Fig. 1).

In the present study, the hormone IBA (2.0 mg l^{-1}) played an important role in rooting of *A. calva* shoots on hydroponics with different strengths of MS medium. Similar results were observed by Jeyachandran *et al.* (2004) in *Anicochilos carnosa* where IBA treated MS medium revealed better shooting at ¼ strength. Also, Sahni and Gupta (2002) reported development of multiple shoots in ½ strength MS medium with 14.7µM of IBA treated *Acacia catechu*. Whereas, the propagation of softwood cuttings of *Pistacia vera* was achieved by Al Barazi and Schwabe (1982) after the treatments of different concentrations (upto 45000 rpm) of IBA. The stem cutting of *Rubia cordifolia* (L.) treated with the combination of IBA and NAA at 2000 rpm each auxin produced high number of roots (24.82 roots/ cutting). Combination of NAA and kinetin were needed for rooting of *Arachis* species (Laxmi and Giri, 2003) and 2,4-D and kinetin *in Boerhaavia diffusa*. A study on relationship of soil fertility and leaf nutrient status in Litchi. It was reported that, nutrients such as N, P, K, Ca and C in leaf is positively correlated to the fertility status of the soil (Kumar *et al.,* 2021). But the present study provides a strong proof that hydroponic system with different strengths of MS medium showed greater response in rooting, shooting and overall development of plantlet. Thus, ensuring that the growth of *A. calva* in hydroponic system revealed better growth and development in the quality of the plant than in soil system.

Of the different media used, the MS medium was more effective in root initiation than the modified Hoagland

medium. In the present study the low strength (1/10) of MS medium produced rooting. Our results are in accordance with the report of Karthic and Seshadri (2009), they reported that *Gymnema sylvestre* stem cuttings produced roots under hydroponic system with 1/10 MS salts supplemented with different IBA concentration. In contrast to the present study, the works of Rudra and Jawarkar (2002) in *Punica granatum*, Sahni and Gupta (2002) in *Acacia catechu*, Benniamin *et al.* (2004) in *Cratarva magna* have reported that, the half strength MS liquid medium was proved to be best for hydroponic system. However, in the present findings, the percentage of response was low in low concentration of modified Hoagland medium. When the concentration is lowered, it does not support the growth of root system in nutrient medium. Deficiencies of the essential element resulted in the abnormalities of plants like chlorosis and necrosis. This essentiality of particular mineral could be known by using artificial methods of solution culture reported by Verma (2009). Whereas, the increasing concentration (1.0 – 2.0X) of modified Hoagland medium resulted in maximum growth in *Saliva splendens* was observed by Kang and van Iersel (2004). In contrary to the present findings, a report by Aseafa and Wagari (2021) on organic vermicompost, supplemented with NPS greatly improved the soil fertility and nutrient content of the soil for the growth of *Glycine max* with high yield capacity. But, the nutrient supplemented hydroponic medium developed in the present study breaks the importance of external addition of fertilizers and role of other soil parameters for the growth and yield of the plant. The concentrations selected for the study was found to be beneficial in the rooting *A. calva*. The strength of MS medium such as 1/6, 1/8, 1/10 and 1/2 strength of modified Hoagland medium were proved to be effective in the rooting of *A. calva*.

Hence, it is proved that the soilless system of cropping (hydroponic system) is very effective for large scale production and conservation of an important medicinal plant *Acmella calva*. The study also helps to avoid major problems faced by farmers like excessive usage of lands, fertilizers, pesticides, manure and search of different types of soil specific to each plant variety, thus providing an effective method with use of small space for the development of nutritionally effective traditional medicinal plants, ultimately encouraging the economic status of the farmers. This hydroponic system based growth of plant is cost-effective, produce high yield in less time would significantly help agronomists to improve the economic welfare of the country to promote, conserve and preserve this important medicinally valuable plant with pharmaceutical importance for the future world.

The inclusive results of the present experimentation evidenced the surplus rooting of *Acmella calva* developed hydroponically using different nutrient medium. *A. calva* is a traditionally important medicinal plant used to treat various diseases is less noticed in medicinal field and it is imperative to conserve the plant for near future. Beside the general advantages of this culture system, such as IBA treated plants in mineral nutrition and access to root system development, test tubes and plant-holders were also designed for flexibility, easy setting up and low maintenance of the culture, so that this hydroponic design will be suitable for many experimental purposes.

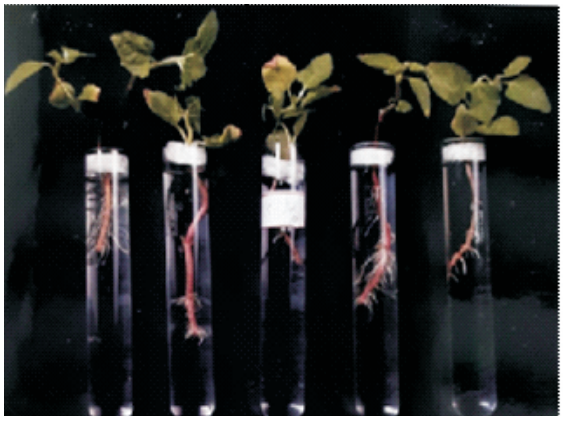
Soilless agriculture or hydroponic system is much preferred in our country due to its various advantages in the agronomy. In the present study, the optimum condition maintained for the growth of experimental plant *A.calva,* is authentically validated for its growth in hydroponic agriculture. This reproducible protocol could be a better alternative for the cultivation of traditional medicinal crops and other plants in the soilless medium and provide a ray of hope for the vulnerable farmers to battle against their socioeconomic condition in the society. Further studies on mass cultivation of *A. calva* will be carried out in hydroponics as future aspect.

Figure 1. Effect of Hydroponics on rooting of A. calva

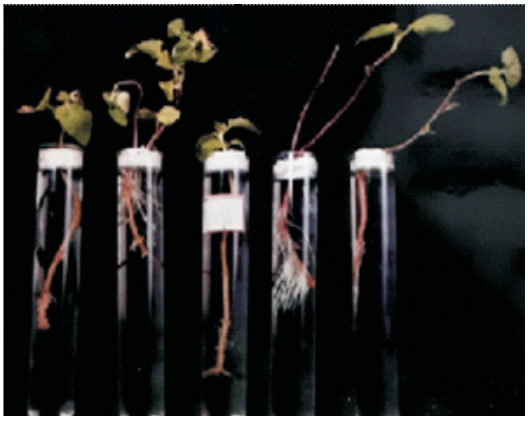
1a. 1/2 strength MS Medium

1b. 1/4 strength MS Medium

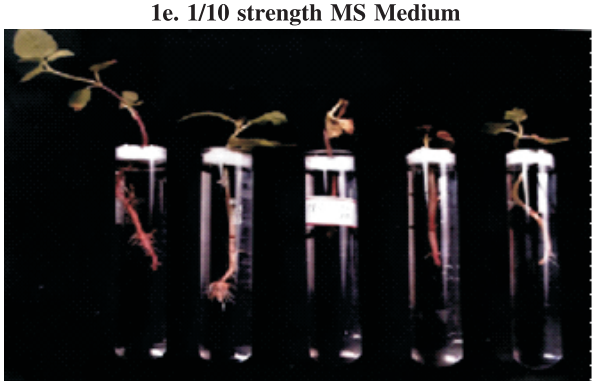
1c. 1/6 strength MS Medium



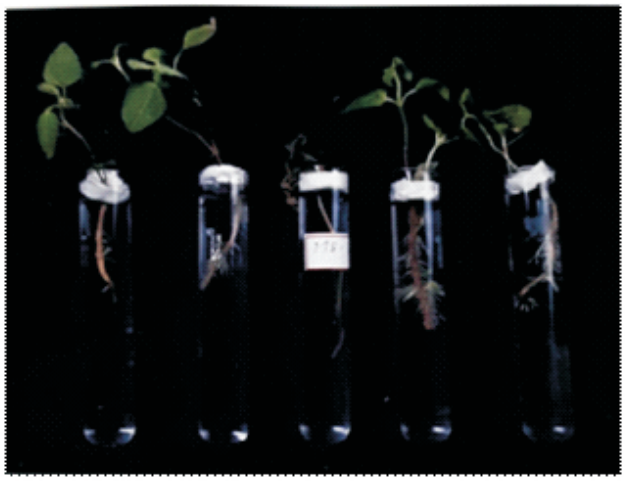
1d. 1/8 strength MS Medium



1e. 1/10 strength MS Medium



1f. 1/2 strength modified Hoagland Medium



1g. strength modifiedd Hoagland Medium

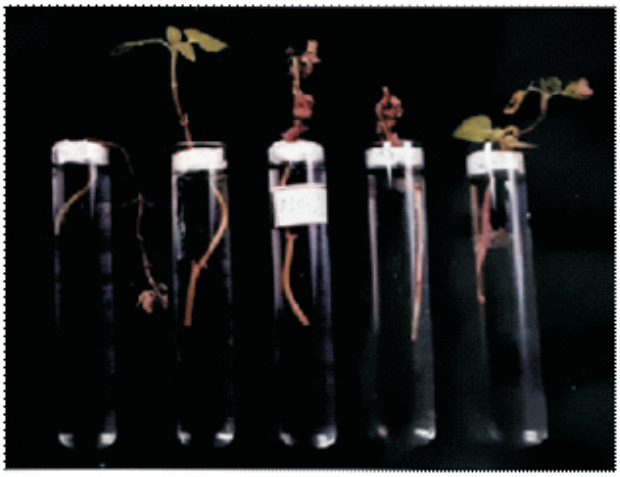


Table 1. Effect of different medium at various concentrations on rooting of *A.calva*

Sr. No.	Growth Medium	Different Concentrations	No.of roots	Root length (cm)	% of response
1.	MS Medium	1/2 strength	6	1.50	80
		1/4 strength	2	1.25	20
		1/6 strength	11	2.88	100
		1/8 strength	9	2.12	100
		1/10 strength	16	3.20	100
2.	Modified Hoagland Medium	1/2 strength	16	2.21	100
		1/4 strength	3	1.73	70
		1/6 strength	5	3.62	90
		1/8 strength	4	2.87	70
		1/10 strength	2	1.84	40
3.	IBA Treated	2.0 mg l^{-1}	15	4.21	90
4.	Control	Sterile distilled water	10	3.34	100

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