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Influence of soilless culture system on growth and biochemistry of horse gram- *Macrotyloma uniflorum* (Lam.) Verdc.

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Abstract
The effect of 3 different concentrations of hydroponic nutrient solution on germination, growth and biochemical content of *Macrotyloma uniflorum* (Lam.) Verdc. using two types of pots- Plastic and Mud pots were studied using coir dust as potting media. The germination rate, shoot length and root length were found to be higher in plants grown in Conc. III (Plastic pots) wherein carbohydrate, protein and chlorophyll content of the plants were found to be higher in Conc. II (Plastic pots). Hence this study recommends the use of Conc. II and Conc. III for soilless culture of horse gram in Plastic pots.

Keywords: *Macrotyloma uniflorum* (Lam.) Verdc., Soilless culture, Hydroponics

1. Introduction
Hydroponics is often defined as "the cultivation of plants without soil". It is a practice of growing plants in containers, it has been tried in the past in order to supply rare fruits and vegetables to wealthy people. In 1970s the complete nutrient solutions, coupled with appropriate rooting media have developed and the researchers studied how to optimize the levels of water, oxygen and nutrients of soilless media. First in The Netherlands, this knowledge base enabled the development of food production in soilless media and later in few other countries. Since the onset of the commercial application of soilless culture, this production approach has evolved throughout the world.
Cultivating plants without soil eliminates the need for vast farmland and allows crops to be produced in greenhouses. This technique needs only precise water and nutrient application directly to the roots of each and every plant. This method of growing plants without soil falls into two general categories:

(a) Liquid culture (true hydroponics), the nutrient solution is circulated and recirculated after reaeration, the adjustment of the pH and nutrient levels were made, e.g. Nutrient Film Technology (NFT),

(b) Aggregate culture, where the nutrient solution is supplied to plants through the supporting media and the excess solution is recirculated or passed as waste (e.g. rock wool, pumice, perlite, etc).
A very important aspect of establishing soilless culture through aggregate culture is the selection of the proper growing media. Coir dust is the remaining waste product when long fibers are extracted from coconut husk (*Cocos nucifera* L.). Coir dust has many supporting media characteristics such as easily wettable, acceptable pH, high water holding capacity, slow decomposition, absence of weeds and pathogens and a renewable resource (Cresswell, 1992; Lennartsson, 1997; Abad, *et al*., 2005; Pill and Ridley, 1998; Verdonck *et al*., 1983; Martinez *et al*.,1997)[2, 3, 1, 5, 7, 4]. Due to these favorable characteristics, an attempt has been made to grow *Macrotyloma uniflorum* (Lam.) Verdc. In coir dust as potting medium, since growing pulses in hydroponic system has not been given much importance.

2. Materials and Methods

2.1. Seeds used

The selected healthy seeds of Horse gram (*Macrotyloma uniflorum)* were collected from Tamil Nadu Agricultural University (TNAU), Coimbatore. They were surface sterilized, then soaked overnight and used for the study.

2.2. Preparation of hydroponic nutrient solution

S. No	Elements	mg/ l		
		CONC.I	CONC.II	CONC.III
1.	Ammonium nitrate	100	200	250
2.	Ammonium dihydrogen orthophosphate	30	40	50
3.	Potassium nitrate	100	200	300
4.	Calcium nitrate	80	85	90
5.	Magnesium sulphate	30	50	70
6.	EDTA (Iron)	1.0	2.0	3.0
7.	Copper sulphate	0.10	0.15	0.20
8.	Manganese sulphate	0.5	0.75	1.0
9.	Zinc sulphate	0.3	0.4	0.5
10.	Boric acid	0.3	0.4	0.5
11.	Sodium chloride	50	60	70
12.	Ammonium molybdate	30	40	50

Number of seedlings / treatments: 25 Number of treatments: 8

T_1- Plastic pots

T_1 a - Control (Soil + Sand, 3:1 ratio i.e., 300 g +100 g)
T_1 b - Concentration I (Coir dust 150 g)
T_1 c - Concentration II (Coir dust 150 g)
T_1 d - Concentration III (Coir dust 150 g)

T_2- Mud pots

T_2 a - Control (Soil + Sand, 3:1 ratio i.e., 300 g +100 g)
T_2 b - Concentration I (Coir dust 150 g)
T_2 c - Concentration II (Coir dust 150 g)
T_2 d - Concentration III (Coir dust 150 g)

2.3. Preparation of potting medium

Pots were filled with 150 g of the coir dust. In T_1 (Plastic pots), height is about 12.5 cm and the diameter is about 14.5 cm. In T_2 (Mud pots), height is about 13 cm and the diameter is about 16.5 cm.

About 150 ml of various concentrations of the hydroponic nutrient solution were added to their respective pots and 25 seeds/each pot were sown. The seeds were periodically moistened with 50 ml of their respective hydroponic nutrient solution. A control was maintained by soaking and growing the seeds in tap water filled with 300g of soil + 100g of sand.

2.4. Germination studies

The germination percentage for each concentration was calculated for 7^{th}, 14^{th}, 21^{th} day.

2.5. Morphological studies

In morphological studies, randomly 5 plants were selected and the shoot length, root length of the plant was measured on 7^{th}, 14^{th}, 21^{th} day, then the mean value was calculated and expressed in cm.

2.6. Biochemical analysis

The plants which were harvested for morphological analysis, were used for the analysis of total soluble carbohydrates, proteins and chlorophyll content (Sadasivam and Manickam, 2008) [6].

3. Results and Discussion

Commercial hydroponics is a modern technology involving plant growth on inert media in place of the soil, to increase the productivity of crop interms of problems associated with the ground, such as soil-borne diseases, poor physical properties, non-arable soil, etc. Various non-toxic porous materials were used as plant growth substrates, including perlite, rock wool, pumice, coir dust, expanded clay, etc., in the substrate, a balanced distribution of small and larger pores is required to ensure adequate availability of water to the plants without affecting the supply of oxygen to the roots. Moreover, the complete control of nutrition via the nutrient solution may enable an enhancement of quality of the products, particularly in vegetable crops, such as melon, lettuce and tomato. Hydroponics results in a decreased application of pesticides and insecticides, enormously used in soil-grown crops to control soil-borne pathogens. The recycling of the excess nutrient solution that drains off after each watering application may contribute to a considerable reduction of nitrate and phosphate leaching to surface and ground water resources.

In Mud pots, germination percentage was higher in Conc. III (64%) on 7^{th} day. Germination percentage slightly increased after a week, with the use of nutrients showed similar increase and increased upto 88% on 21st day. When Plastic pots were used, on 7^{th} day Conc. III showed higher germination (68%), but after two weeks there was notable increase in percentage germination in Conc. III (92%) (21^{st} day). (Table- I).

In Mud pots, on 7^{th} day no great difference was noted on the shoot length in the concentrations. After two weeks, Conc. III (11.0 cm) showed increased shoot length. In plastic pots, on 7^{th} day no significant difference was noted between Conc. II (4.7 cm) and Conc. III (4.8 cm). However on 21^{st} day Conc. III showed higher shoot length (12.0 cm). (Table- IIa).

In Control both Plastic and Mud pots the root length were (1.2 cm, 1.1 cm respectively) much less even upto 21^{st} day (2.8 cm and 2.9 cm respectively). Conc. III seemed to be good for increasing root length (5.7 cm) on 21^{st} day in Mud pots, when Plastic pots were used Conc. II and Conc. III showed almost similar results, 3.8 cm and 3.9 cm respectively, on 7^{th} day. After two weeks Conc. III showed higher root length (5.8 cm) on 21^{st} day. (Table- IIb).

Conc. II was found to be favourable for increasing the carbohydrate content when both Plastic (1.26±0.03 mg/g) and Mud pots (1.26±0.02 mg/g) were used on 21^{st} day. In Mud pots, Conc. III (0.78±0.03 mg/g) seemed to be better on 7^{th} day, but after two weeks in Conc. II (1.26±0.02 mg/g) carbohydrate content increased. In Plastic pots, Conc. II (0.78±0.07 mg/g) seemed to be better on 7^{th} day. (Table- III).

In both Plastic (1.57±0.07 mg/g) and Mud pots (1.52±0.05 mg/g) Conc. II enhanced protein content significantly on 21^{st} day. (Table- IV).

Conc. II favoured increase in chlorophyll content from 7^{th} day to 21^{st} day, when grown in both Plastic (0.3966 mg/g) and Mud pots (0.3842 mg/g). (Table- V).

Germination rate, shoot length and root length were maximum when Conc. III was used. Carbohydrate, protein and chlorophyll content were maximum in Conc. II itself, though this concentration did not enhance growth and germination. The results indicate that though increased concentration of micronutrients enhance the growth of plants and to increase biochemical contents, some more macronutrients have to be added in Conc. III to get better

results both interms of growth and biochemical contents. Further work on this aspect with addition of macronutrients such as carbon and nitrogen might prove the use of various nutrients used in the present study for their application in growing hydroponic plants.

Table I: Effect of hydroponic nutrient concentration on the germination percentage of the seeds of *Macrotyloma uniflorum* (Lam.) Verdc.

S. No	Treatments	Germination Rate (%)					
		Mud pots			Plastic pots		
		7th Day	14th Day	21st Day	7th Day	14th Day	21st Day
1	Control	60	80	80	60	64	64
2	Conc. I	56	84	88	64	80	80
3	Conc. II	56	84	88	56	84	84
4	Conc. III	64	88	88	68	88	92

Table II: Effect of hydroponic nutrient concentration on the seedling growth of *Macrotyloma uniflorum* (Lam.) Verdc.

Table IIa:

S. No	Treatments	Shoot length (in Cms)					
		Mud pots			Plastic pots		
		7th Day	14th Day	21st Day	7th Day	14th Day	21st Day
1	Control	3.7	6.5	9.8	4.2	6.9	9.7
2	Conc. I	3.2	6.1	8.5	4.0	6.8	9.5
3	Conc. II	3.5	6.2	9.0	4.7	7.3	10.0
4	Conc. III	3.8	7.8	11.0	4.8	8.2	12.0

Table IIb:

S. No	Treatments	Root length (in Cms)					
		Mud pots			Plastic pots		
		7th Day	14th Day	21st Day	7th Day	14th Day	21st Day
1	Control	1.1	2.1	2.9	1.2	2.4	2.8
2	Conc. I	3.1	4.4	5.1	3.3	4.1	5.0
3	Conc. II	3.3	4.8	5.3	3.8	4.2	5.2
4	Conc. III	3.7	4.8	5.7	3.9	4.4	5.8

Table III: Effect of hydroponic nutrient concentration on the carbohydrate content of the seedling of *Macrotyloma uniflorum* (Lam.) Verdc.

S.No	Treatments	Carbohydrate content mg/g					
		Mud pots			Plastic pots		
		7th Day	14th Day	21st Day	7th Day	14th Day	21st Day
1	Control	0.76±0.01	0.90±0.04	1.18±0.05	0.75±0.03	0.92±0.06	1.20±0.05
2	Conc. I	0.73±0.03	0.89±0.07	1.23±0.02	0.72±0.05	0.91±0.01	1.15±0.02
3	Conc. II	0.77±0.02	0.92±0.08	1.26±0.02	0.78±0.07	0.95±0.02	1.26±0.03
4	Conc. III	0.78±0.03	0.87±0.02	1.21±0.08	0.73±0.03	0.85±0.06	1.19±0.09

Table IV: Effect of hydroponic nutrient concentration on the protein content of the seedling of *Macrotyloma uniflorum* (Lam.) Verdc.

S.No	Treatments	Protein content mg/g					
		Mud pots			Plastic pots		
		7th Day	14th Day	21st Day	7th Day	14th Day	21st Day
1	Control	0.87±0.05	1.15±0.08	1.29±0.08	0.89±0.07	1.13±0.01	1.32±0.06
2	Conc. I	0.90±0.06	1.20±0.03	1.41±0.03	0.94±0.04	1.23±0.08	1.47±0.03
3	Conc. II	0.98±0.08	1.26±0.01	1.52±0.05	1.05±0.02	1.28±0.03	1.57±0.07
4	Conc. III	0.95±0.02	1.25±0.07	1.49±0.04	1.01±0.05	1.23±0.04	1.50±0.02

Table V: Effect of hydroponic nutrient concentration on the chlorophyll content of the seedling of *Macrotyloma uniflorum* (Lam.) Verdc.

S.No	Treatments	Chlorophyll content mg/g					
		Mud pots			Plastic pots		
		7th Day	14th Day	21st Day	7th Day	14th Day	21st Day
1	Control	0.0465	0.1720	0.3475	0.0481	0.1764	0.3724
2	Conc. I	0.0459	0.1780	0.3752	0.0426	0.1708	0.3558
3	Conc. II	0.0478	0.1812	0.3842	0.0484	0.1826	0.3966
4	Conc. III	0.0468	0.1746	0.3566	0.0465	0.1786	0.3659

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