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CULTIVATION OF LEAFY VEGETABLES BY NON-CIRCULATING HYDROPONIC METHOD: REVIEW

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Abstract: Soil is usually the most available growing medium for plants. It provides anchorage, nutrients, air, water, etc. for successful plant growth. However, soils do pose serious limitations for plant growth too, at times. The aim of the review is to present an overview of the cultivation of leafy vegetables by non-circulating hydroponic method on the growth, development, yield and quality of vegetables grown under greenhouse conditions and also under non-controlled environment. Non-circulating method shows that it is the simple and inexpensive system. It can be used on any level area in the production of short season leafy vegetable crops.

Keywords: Soil, Vegetables, Environment

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INTRODUCTION

Soil is usually the most available growing medium for plants. It provides anchorage, nutrients, air, water, etc. for successful plant growth. However, soils do pose serious limitations for plant growth too, at times. Presence of disease causing organisms and nematodes, unsuitable soil reaction, unfavorable soil compaction, poor drainage, degradation due to erosion etc. are some of them. In addition, conventional crop growing in soil (Open Field Agriculture) is somewhat difficult as it involves large space, lot of labour and large volume of water. Moreover, some places like metropolitan areas, soil is not available for crop growing at all, or in some areas, we find scarcity of fertile cultivable arable lands due to their unfavorable geographical or topographical conditions. Of late, another serious problem experienced since is the difficulty to hire labour for conventional open field agriculture. Under such circumstances, soil-less culture can be introduced successfully (Mamta D. Sardare & Shraddha V. Admane, 2013).

The technology for food production in greenhouses has advanced a great deal in the last 20 years. Greenhouse food production often termed controlled environment agriculture (CEA) usually accompanies hydroponics. (Merle H. Jensen, 1999). Soil-less culture mainly refers to the techniques of Hydroponics' and Aeroponics'. The term Hydroponics' was derived from the Greek words *hydro'* means water and *ponos'* means labour. It is a method of growing plants using mineral nutrient solutions, without soil. In India, Hydroponics was introduced in year 1946 by an English scientist, W. J. Shalto Duglas and he established a laboratory in Kalimpong area, West Bengal. He has also written a book on Hydroponics, named as Hydroponics, The Bengal System'. Later on during 1960s and 70s, commercial hydroponics farms were developed in Abu Dhabi, Arizona, Belgium, California, Denmark, German, Holland, Iran, Italy, Japan, Russian Federation and other countries. During 1980s, many automated and computerized hydroponics farms were established around the world. Home hydroponics kits became popular during 1990s(Mamta D. Sardare & Shraddha V. Admane, 2013).Hydroponics is the culture of plants in nutrient solutions. Controlled applications of a properly balanced, diluted nutrient solution are made at .regular intervals to meet plant needs for nutrients and water. This· results in uniformly high-quality produce-in taste, appearance, and· nutritional content.(Kenneth W. Leonhardt & Wade W. McCall, 1914).

NON-CIRCULATING HYDROPONIC METHOD-

The suspended pot, non-circulating hydroponic method is a unique and powerful technique for growing vegetables because the entire crop can be grown with only an initial application of water and nutrients. This system is extremely efficient with water use. The additional production costs and complexities associated with aeration and circulation including the need for electrical power and pumps in many conventional hydroponic systems are totally avoided by this method. The basic concepts of non-circulating hydroponic systems include: 1) The upper part of the root system should be exposed to air with high relative humidity; 2) Roots must not be allowed to dry out; 3) The lower portion of the rootsystem should gather water and nutrients; 4.) Nutrient solution level may remain the same or be lowered, but it may not be raised or else the roots will 'drown'. (B.A. Kratky, 2004).This system is very suitable for short-term crops like lettuce with a relatively low water requirement. However, a long term crop like tomatoes has a high water requirement and it would be costly to build large tanks to supply the entire crop with nutrient solution(B.A. Kratky, 2005).

Charles A. Fedunak & Richard V. Tyson (1997) research conducted for low-tech non-circulating hydroponics for the lettuce cultivation. Winter and spring (1997) lettuce (*Lactuca sativa*) variety selected for the trials conducted at

the Horticulture Learning Center in Tavares, FL in new low-tech hydroponic system. The system was setup in a greenhouse with open screened sides and no environmental controls. Total four hydroponic growth frames were constructed for the trial. Each variety of lettuce was produced in each growing frame, resulting in a total of four replications per variety was taken. Frames were constructed by different material like 1) 2- 96 inches pressure treated white pine 2 X 4. 2) 2-45 inches pressure treated white pine 2 x 4. 3) 1-96 inch x 48 inch sheet of ½ inch plywood. 4) 1-96 inch x 48 inch sheet of 2 inch Styrofoam. 5) 1-120 inch x 60 inch piece of 10 mil polyethylene. 4ft x 8ft rectangular frame is constructed. Forty-five 2 inch diameter holes were cut out with a key hole saw in the sheet of Styrofoam 10 inch on center.Growing frame is filled with the water to within approximately 1 inch from top edge. Water soluble fertilizers are added in the amount of 0.6 lb Nutri-sol 4-5-26 (4-2, 2-21, N-P-K) and minors Hydroponic basic mix (part-1) and 19.5 oz of $CaNO_3$, liquid fertilizers was dissolved in water. The plastic cup containing the lettuce seedlings was than placed in the holes. A bitterness and quality test were administered using 20 participants. Following table shows the spring and winter yield and quality results.

Table 1: Winter lettuce yield and quality results.

Variety	Avg. plant wt. (oz)	Quality Rating	Bitterness Rating
Salina	6.6	4	3
Tango	9.4	2	4
Ermosa	8.3	1	1
Optima	8.2	3	2

Varieties were compared for quality (texture and taste), 1 being best and 4 being the least.

Varieties were compared for bitterness starting with 1 being the least and 4 being the bitterest.

Table 2: Spring lettuce yield and quality results.

Variety	Avg. plant wt. (oz)	Quality Rating	Bitterness Rating	Avg. No. Plants Bolting
Salina	4.7	5	5	0.0
Tango	6.0	4	6	1.1
Ermosa	9.7	1	1	2.4
Optima	10.5	3	3	2.8
Nancy	7.1	6	4	1.5
Green Ice	7.2	2	2	1.9

Varieties were compared for quality (texture and taste), 1 being best and 6 being the least.

Varieties were compared for bitterness starting with 1 being the least and 6 being the bitterest.

From the all observations results shows that Salina Showed excellent heat tolerance in the spring season. Ermosa ranked highest in overall quality in both trials.

B. A. Kratky (2002), in this experiment he show that any person can took a small scale production of vegetable at home. He took the 1-gallon plastic cranberry juice bottle or equivalent with 1½-inch opening and net pot (1½-inch diameter x 3 inches long) also growing medium (may contain at least two of like peat, perlite, vermiculite, coir) Seed of the short-term crop (such as lettuce or kai choy). He rinse the plastic bottle with water twice. Do not use bleach. If dish soap is used, rinse several times to remove the soap. Then added a teaspoon of hydroponic fertilizer (such as Chem-Gro® 10-8-22) to the bottle and about 1 quart of water to the bottle and swirl the bottle to dissolve some of the fertilizer. The nutrient solution (water plus fertilizer) will turn a cloudy, light yellow-green color. The plastic, slotted container is called a "net pot" in the hydroponic supply trade filled with the growing medium. Make a ¼-inch deep hole in the moist growing medium. Plant 1 or 2 seeds of lettuce or kai choy. (Kai choy is a type of mustard cabbage adapted to warm areas.) Cover the seeds lightly. Then placed the bottle in a location that receives plenty of light but is protected from wind and rain.The seed should germinate in 2–4 days.B. A. Kratky suggest that leave the bottle alone for the next 5–6 weeks. Do not pull the net pot from the bottle—the roots will be damaged. Do not add any more water or fertilizer. After the complete growth harvest the crop.

"Net pot" to contain the growing medium.Lettuce plants ready for harvest.

B.A. Kratky (2004) research conducted to study the suspended pot non-circulating hydroponic method only requires an initial application of non-circulating nutrient solution which must be of sufficient quantity to supply the entire cropping period. Electricity and pumps are not needed. Tanks are filled nearly to the top with 8 cm or more (depending upon the tank depth) of an appropriate nutrient solution for the crop to be grown. Tapered plastic containers (ideally, net pots or forestry tubes with additional apertures in their sidewalls) holding seedlings in growing medium are transplanted such that they are supported by the tank cover. The lower 2 cm or greater of the containers are immersed in nutrient solution, thus automatically watering and fertilizing the plants by capillary action. Methods for growing cucumbers (*Cucumis sativus* L.), lettuce *(Lactuca sativa* L.*)* and tomatoes *(Lycopersicon esculentum Mill.)* are described. This methodology has been granted 2 U.S. Patents and users include hobbyists, educational institutions (no weekend watering is required!), researchers and commercial growers.

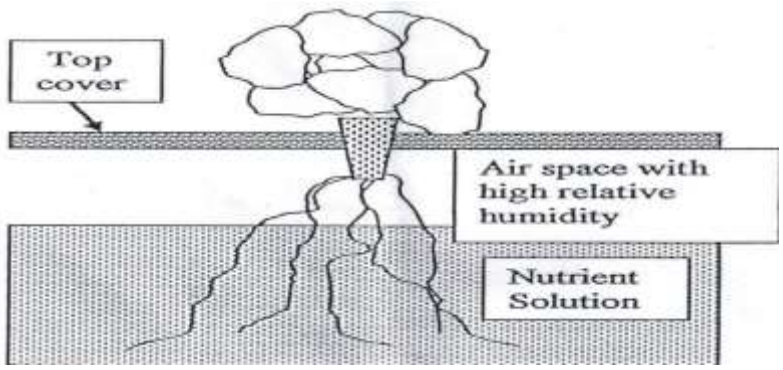

Fig. 1. A model suspended pot, non-circulating hydroponic system after the nutrientsolution has dropped below the seedling container

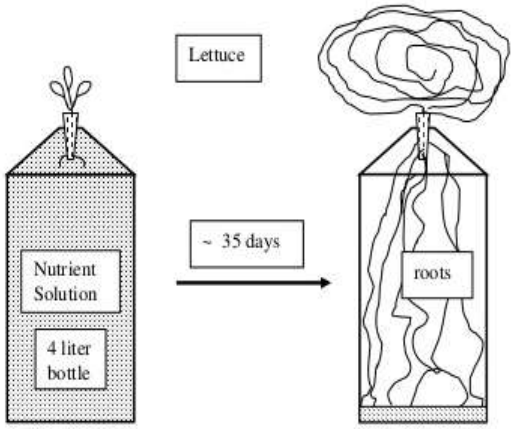

Fig. 2. Lettuce growing in a 4-liter plastic juice bottle

Growing lettuce in a commercial-sized tank-

In its simplest configuration, a tank is constructed by nailing 3.8 x 8.9 cm dimension lumber to a 1.9 cm thick plywood sheet (1.2 x 2.4 m) and lined with 2 layers of 0.15 mm-thick black polyethylene sheeting. The tank is supported on concrete blocks or a lumber support and leveled. Tanks are covered with 2.5 cm thick expanded polystyrene bead board (0.032 g/cc density), but extruded polystyrene boards, plywood sheets.

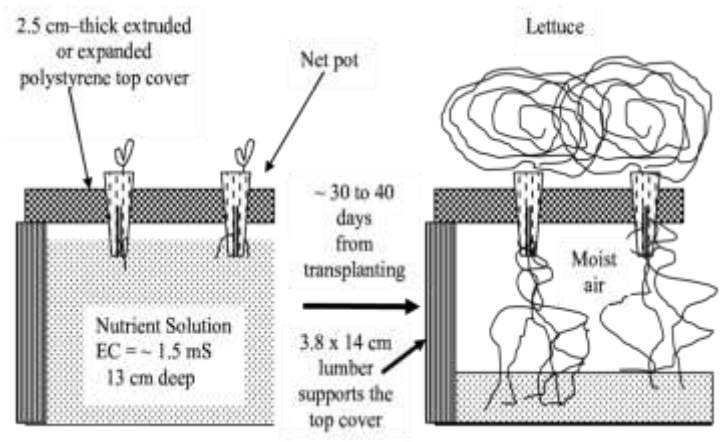

Fig. 3. Growing lettuce in a commercial-sized tank

B.A. Kratky, *et al.*(2008) they conducted for Study Growing Lettuce By A Float-Support Non-Circulating Hydroponic Method in Hawaii and Pennyslvania. Styrofoam boards (61 x 122 cm) were configured to hold 12 lettuce plants in net pots. They floated on nutrient solution in a 14 cm deep tank and came to rest on 8, 10 and 12 cm diameter plastic pipes as nutrient solution was lost by evaporation and transpiration, thus creating 3 different heights of humidified air spaces. There were also continuously floating and fixed supported treatments. There was only an initial application of water and nutrients. Electrical power and pumps were not needed for aeration and circulation. Yields from semi-head, romaine and leafy cultivars were similar for the fixed supported, continuously floating and the float-support treatments in the Pennsylvania trials. The same was true for leafy and semi-head cultivars in the Hawaii trials. However, romaine lettuce yields were significantly lower in continuously floating and 8 cm float-support treatments than fixed supported and 10 and 12 cm float-support treatments in the Hawaii trials. Heads were allowed to develop to a larger size in the Hawaii trials, because bolting was not a serious threat in the cool upper elevation climate.

B.A. Kratky, *et al.* (2005) they studied that 'Big Beef' tomatoes produced 2.68 kg/plant from a 72 day harvest period when they were grown in 0.35 liter aluminum beverage cans by a sub-irrigation hydroponic method. Tomatoes growing in net pots (70 ml) suspended by expanded polystyrene bead boards with a sub-irrigation method gave similar yields in one trial but lower yields in another trial than tomatoes growing in beverage cans. Tomatoes growing in 10 cm square plastic pots filled with perlite (700 ml) rested on 5 cm high upside-down nursery trays and yielded significantly higher than plants growing in aluminum beverage cans resting on the tank floor in 2 trials. Placing a 5 cm high nursery tray as a support for a 10 cm pot increases the root exposure to moist air (i.e. air between the nutrient solution surface and the tank cover) and provides a net-type surface which encourages root formation and anchorage. Hawaii's lower elevations are warm and very conducive to mosquito reproduction in these non-circulating hydroponic tanks. In an effort to control mosquitoes, window screen was supported on the nursery tray above the nutrient solution level, thus trapping newly hatched mosquitoes below the screen where they eventually died. Tomatoes were also grown in 7.6 liter pots which were sub-irrigated by microtubes. Each pot contained an upside-down 3.8 liter pot with slits, so only 3.8 liters of cinder growing medium was needed to fill the pot. In several cases, roots grew into the microtubes supplying the nutrient solution and this blocked nutrient flow to the pots, thus killing the plants. Tomatoes growing in both of these mosquito-proof systems yielded similarly when protected by a simple polyethylene rainshelter from 158 cm of rainfall during the

growing period, but unprotected tomato plants yielded 55 per cent lower in the pot-screen-tank system and no salable yields were obtained from the unprotected sub-irrigated 7.6 liter pots.

B.A. Kratky (2009), research conducted to describe the three non-circulating hydroponic methods for growing lettuce are described which do not require electricity, pumps or wicks. All of the nutrient solution is added prior to planting or transplanting. In the simplest system, lettuce is seeded in a tapered plastic net pot filled with growing medium and placed in a darkened, 4-liter plastic bottle filled with nutrient solution with the lower 3-cm-portion of the pot immersed in nutrient solution. In second method for a commercial scale employs a 14 cm high tank lined with polyethylene sheeting which is filled with nutrient solution and covered with an expanded or extruded polystyrene sheet resting on the tank frame. Lettuce is planted or transplanted into net pots filled with growing medium and placed in holes in the cover. In the last method modification is done which shows a float-support system in long rectangular raceway tanks. Lettuce is planted or transplanted into net pots placed in a sheet of extruded polystyrene. The cover initially floats on the nutrient solution, and then, comes to rest on 2 parallel plastic pipes (10 cm diam.) resting on the tank floor as the nutrient solution level recedes due to plant growth. The tank is filled with water immediately prior to harvesting and floating rafts may be easily moved to a harvesting station.

CONCLUSION:-

This Non-circulating hydroponic system proved to be a relatively simple and inexpensive system. It can be used on any level of area for the production of short duration crop like vegetables. But for the leafy vegetables it is the most beneficial method. System setup does not require any maintenance. The industry is expected to grow exponentially also in future, as conditions of soil growing is becoming difficult. In India , where urbanization is growing each day there is no option but adopting soil-less culture to help improve the yield and quality of the produce so that we can ensure food security of our country. Also there is need to take a quick against the food scarcity.

REFERENCES:

1. Charles A. Fedunak & Richard V. Tyson (1997) Lettuce Cultivars For Low-Tech Non-Circulating hydroponics, Proc. Fla. State Hort. Soc. 110 p. 384-385.

2. Harry Ako and Adam Baker (2009) Small-Scale Lettuce Production with Hydroponics or Aquaponics, Sustainable Agriculture, SA-2

3. Kenneth W. Leonhardt & Wade W. McCall Hydroponics (1914) General Home Garden series No. 35 College of Tropical Agriculture and Human Resources University of Hawaii

4. Kratky B.A. (2002) A Simple Hydroponic Growing Kit for Short-Term Vegetables, Home Garden, HG-42

5. Kratky B.A. (2004) A Suspended Pot, Non-Circulating Hydroponic Method proceedings of the South Pacific Soilless Culture Conference, Acta Hort. 648. p. 83-89

6. Kratky B. A. (2005) Non-Circulating Hydroponic Methods for Growing Tomatoes, National Agricultural Plastics Congress 32, p. 31-36

7. Kratky B.A., G.T. Maehira and E.J. Magno (2008) Growing lettuce by a float-support non-circulating hydroponic method in Hawaii and Pennsylvania, 34th National Agricultural Plastics Congress. American Society for Plasticulture, Bellafonte, PA(published on a CD).

8. Kratky B. A. (2009) Three non-circulating hydroponic methods for growing lettuce. Proceedings of the International Symposium on Soilless Culture and Hydroponics. Acta. Hort. 843:65-72.

9. Kratky B. A. (2010) A Suspended Net-Pot, Non-Circulating Hydroponic Method for Commercial Production of Leafy, Romaine, and Semi-Head Lettuce, Vegetable Crops, VC-1

10. Mamta D. Sardare & Shraddha V. Admane (2013) A Review On Plant without Soil – Hydroponics, International Journal of Research in Engineering and Technology, Volume: 02 Issue: 03, p. 299-300