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Cultivation of Crops in Hydroponic Systems with Nutrient Film Technique

R. Sudha Rani[1],K. Krupavathi[2], K.N Raj Kumar[3] and H.V Hema Kumar[4]

[1]Ph.D Scholar, Department of Soil and Water Engineering, Dr. NTR College of Agricultural Engineering, Bapatla

[2]Assistant Professor, Department of Irrigation and Drainage Engineering, Dr. NTR College of Agricultural Engineering, Bapatla

[3]Assistant Professor, Department of Soil and Water Engineering, Dr. NTR College of Agricultural Engineering, Bapatla

[4]Professor, Department of Soil and Water Engineering, Dr. NTR College of Agricultural Engineering, Bapatla

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Agriculture is one of the primary occupations of man since early civilization. Agriculture plays an important role in development of economy of nations and is considered as an essential part of human life cycle. By 2050, world population is estimated to be 9 billions thereby increasing food necessity by 70%. To meet food demand of growing population, production of food requires to be doubled. Throughout the world, 50% of the arable land is unsuitable for farming activities. It was estimated that per capita surface water availability declined from 5260 cubic meter per year in 1951 to around 1000 cubic meter in 2016. In conventional soil method, most of the water provided to the crops is leached deep into the soil and is inaccessible to the roots of the crops.

General agriculture is currently facing many defies like urbanization, natural disaster, non-selective and high use of chemicals and pesticides which is diminishing the fertility of the land .And also in recent years, the world has faced a drastic change in climate resulting in increased environmental stresses like untimely floods, change in seasonal temperatures and wind dispatches main reasons for the food crisis. These changes have affected the field of agriculture with in terms of quantity and quality. The degradation and soil erosion due to the traditional farming methods that mainly strips the soil the vitamins and minerals. In view of above reasons, to overcome this shortfall in the yield the world requires to invent techniques to improve and increase the productivity of farming systems., soil less culture.

The soil-less culture is mainly referred to the technique of Hydroponics. The term Hydroponics was derived from the Greek words hydro' means water and ponos' means

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labour. Thus, "Hydroponics" means water work. Soil-less culture began to expand rapidly from the 1970s because it helps controlling accurately the environmental factors of the plants and more specifically, meeting its watering and mineral requirements. In addition, it solves the serious pathologic problems caused by soil borne contamination (Fusarium, verticillium, nematodes). Soilless cultures are now preponderant in most polyhouse cultures, mainly because they prevent contamination problems and make it possible to obtain substantially higher yields.

There are six different types of hydroponic systems in use, which include the following: Nutrient Film Technique, Wick System, Ebb and Flow Method (Flood and Drain), Water Culture Technique, Drip System and Aeroponic System. Among these techniques, the nutrient film technique(NFT system) is very feasible for growing hydroponics crops is also fairly popular with hydroponic growers due to its simple yet effective design. The ability to grow plants vertically or horizontally and the ease of harvesting them using NFT technique makes for a more sustainable approach compared to using other systems. Nutrient Film Technique (NFT) is more geared towards commercial systems.

The Nutrient Film Technique System (NFT) contains a reservoir to hold the nutrient solution. A submersible pump to transport nutrient rich water to the grow tray. Tubes to dispense water from the nutrient pump to the NFT growing tubes. Growing tubes for plants to grow in (also known as Channel). Net pots to hold plants in a growing media. Recirculation system (tubing, channel) to direct used nutrient solution back to the reservoir.

There are sixteen elements needed for plant growth. The primary macronutrients are nitrogen (N), phosphorus (P), and potassium (K).The secondary macronutrients are calcium (Ca), magnesium (Mg), and sulphur (S). These distinctions are made based on how much of each nutrient plants need. Micronutrients, or trace elements, such as iron (Fe), manganese (Mn), boron (B), molybdenum (Mo), zinc (Zn), copper (Cu), and chlorine (Cl) are used in very small amounts by plants, hence the name micronutrients. Micronutrients are sometimes present as impurities in the water and in the solid substrate. Plants extract several of these elements, such as oxygen, carbon, and hydrogen, from water and air.

The growing media used supports plant roots and holds it upright. The media also holds moister andair required by the plants. Media allows plant roots to have maximum exposure to the nutrient. There are many options for hydroponic media, some of most

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common are Clay balls, Cocopeat, Perlite, Vermiculite, Rock wool as shown in Fig.1 (a,b,c,d,e) and locally available media i.e., Gravel, Sand, Sawdust, Coco Coir, Peat Moss, Peat, Pumice, Creek Sand and Phenolic Foam.

Fig.1(a) Clay balls (b) Coco peat (c) Perlite (d) Vermiculite (e) Rock wool

To prepare nutrient solution, 500g of nutrient powder A and 500g of nutrient powder B was mixed with 5 lit of water. The solution was thoroughly stirred and stored at room temperature in an air tight container. The reservoir was filled with water up to 150liters and added 1liter nutrient solution A and 1 lit nutrient solution B. The solution was mixed thoroughly and allowed to circulate into a frame of the hydroponic unit. The nutrient solutions were added as per the treatments to maintain pH and EC of water. pH and TDS were checked regularly and using portable pH and EC meter daily in the morning and adjusted as per treatment requirement.

For growing nursery of any crop for NFT planting requires proper proportion of 60% cocopeat, 20 % perlite and 20% vermiculite (Fig 2). The plug trays were used to grow nursery were filled with the premixed cocopeat up to 1½ inches. The seeds were placed carefully in trays and covered with cocopeat as a layer. The plastic sheet is covered on the trays up to 3 days, after the plastic cover was removed and water is sprayed with spray cans in the morning and evening daily without disturbing the seed. After 15 days the red Amaranth us seedlings as shown in Fig. 4.

Fig.2 Premixed cocopeat filling in tray and sowing of seeds

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Fig.3 after 1-week red amaranth us seedlings **Fig.4 After 15 days seedlings**

The germinated seedlings were transplanted to net caps were placed in the channels of growing frame, where nutrient solution circulates and forms nutrient film around roots of the plant. The nutrient solution A (macro nutrients) and nutrient solution B (micro nutrients). The macro and micro nutrients are essential for the healthy growth of plants.

Vertical hydroponics circulation unit for vertical farming also known as A-frame was used for growing crops. Each A-frame consists of 2.5 m long plastic rectangular pipes carries 20 holes for net caps. On A-frame, 5 sets of plastic rectangular pipes sides arranged on each side as shown in Fig. 5. Single A-frame consists of 200 openings for netpots.

The reservoir (tank) is placed at the bottom of the A-frame, connected to the top of the plastic channels by a pump. The nutrient solution is pumped up from the reservoir to the top channel of the frame with 0.1 HP electric pumps. The channels were sloped slightly in zigzag manner and all channels were connected at the ends so that the nutrient water flows from top channel to the bottom channel. The nutrient solution flows from one side to another side of channel, the surplus nutrient solution will stream/flow out of this pipe and move into bottom channel or tube, and finally to the solution tank/reservoir where it is recalculated through the system again.

Fig.5 Nutrient Film Technique

The plants are transplanted in net pots with growing media into holes provided in the top of the tube (growing channels).The roots of the plants are suspended down to the channel

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where they make contact with the shallow film of the nutrient solution. The shallow film of the nutrient solution allows the plants to absorb nutrients and have access to oxygen in the air without being water logged. The shallow nutrient solution flows all the way through each of the channel having plants in it to the other side, passing by each plant and wetting the roots on the bottom of the channel.

NFT technique is primarily used to grow high value crops, medicinal plants, leafy green vegetables. In NFT system, best suitable crops are Spinach, Red Amaranth us, Green Amaranth us, Lettuce, Spinach, Strawberries, Kale**,** Mint, Coriander, Zucchini, and certain herbs like Basil. Larger plants such as cabbage, Bell pepper, Tomatoes, Broccoli, that take longer to grow, are heavier, and have larger root systems are not suitable for an NFT system.The newly commissioned hydroponic system, at Dr. NTR College of Agricultural Engineering, Bapatla. In this college different crops are grown in NFT system these are: Parsley, Basil and Red Amaranthus.

Fig.6 Transplantation of red amaranth us and Basil

Fig.7 Parsley

Fig.8 Basil

Fig.9 Red Amaranthus

Some of the factors maintain in playhouse for all leafy vegetables crops like pH range 5.5 to 6.0,TDS 650-1200 ppm and 26˚C maximum is best for accelerated growth. Night

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temperatures should not be less than 18˚C**.** The optimum relative humidity during the day is 60-70% and at night between 70-90%.

In NFT system consumption of water and nutrient is low, and it avoids need to use a lot of growing media. It is easy to disinfect roots. Easy to see root quality and health. Consistent flow prevents salt build-up in root area. Recirculating , so minimal ground water contamination. NFT system uses fewer materials. Maintain constant flow of water, constant flow reduces fungal risk. Easy for vertical farming. NFT system can be energy efficient and environmentally friendly.