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# Hydroponics Emerging Technique of Plant Cultivation

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***ABSTRACT:*** *In current epoch most countries in our planet is facing scarcity of food supply. This is screening a serious threat of food security for future generation. Rising population is serving well to stated problem. Not only agricultural scientists but also in the field of molecular biology, chemistry, engineering, botany, zoology etc. researchers are trying hard to overcome the problem of food security. In this article a well established but ostracized technique of plant culture namely "**Hydroponics**" is discussed. This technique is also known as **Nutrient Film Technique** in some part of the world. This technique involves method of plant cultivation without soil. This technique of horticulture proffers much reimbursement in comparison to traditional technique of agriculture. Therefore we can attain high productivity by reducing cost of irrigation, use of pesticide, insecticide, weedicide, diseases caused by fungi, bacteria, and virus. In low land area crop productivity can be maximized in layer cultivation (One layer of crop above another). Future aspects are also good, somehow linked to plant cultivation technique in space crafts, Indoor home gardening, etc. Necessity to develop our traditional mode of agriculture provides significant vigor to initiate work in Hydroponics.*

***Keywords: Hydroponics; scarcity; without soil; reimbursement; productivity; spacecrafts; vigor.***

**INTRODUCTION:** We are well aware of significance of Air, Water, Light, humidity, temperature etc. and other environmental factors in human life. Source of nutrition is also one of the most important requirements of living organism. Major source of nutrition comes from sea food, farm and also agricultural field. Perhaps agriculture is a most common technique to accomplish basic nutritional requirement around globe. Still in the world map many countries with weighty population are unable to provide minimum requirement of nutritional resources to whole population. Limited source of nutrition and mounting population is really a serious problem for higher animals like human beings. Hence, there is a serious need of alteration in traditional technique along with innovation of some other useful practices.

In this article we will discuss about **"Hydroponics"**. In some part of the world it is also known as Nutrient Film Technique (NFT). Actually NFT is one of the types of Hydroponical system. Some of the hydroponical designs have been classified as Water culture, Drip Recovery/Non recovery system, and Wick Hydroponical System. By some means they all are slightly different from each other but following same principle of execution. We cannot disregard the importance of traditional methods of agriculture but somehow we can bring some support and changes into it. Hydroponics is following the easy practice associated with traditional method of agriculture. Literature reveals that this system is ideal for the cultivation of herbs and other annual plants. It also scores over other techniques as regards requirement of space for cultivation. This technique primarily focuses on availability of nutrient to plant species through water. Use of soil is a central part of traditional method, which is kept far away from this technique. In this system of plant cultivation environmental factors are also controlled according to the need and available facilities. Earlier, experimentally it has been proved that this technique is suitable for both outdoor and indoor cultivation of plant species. Level of facility provided could affect the total mass productivity of the plant. For example if we provide indoor environment to the plant, this may reduce the unconstructive effect of outdoor climate factors, microbial population, grazing, insects etc. According to Higgins and Govindan (2002) rice production, declined by 20.7 million ton due to poor monsoon. Chen *et al*. reported that there will be continues decline in corn and soybean productivity by 4-14% and 8-21% up to 2100 in China under effect of climate change. Moreover this is possible to attain plant growth throughout the year without boundation f

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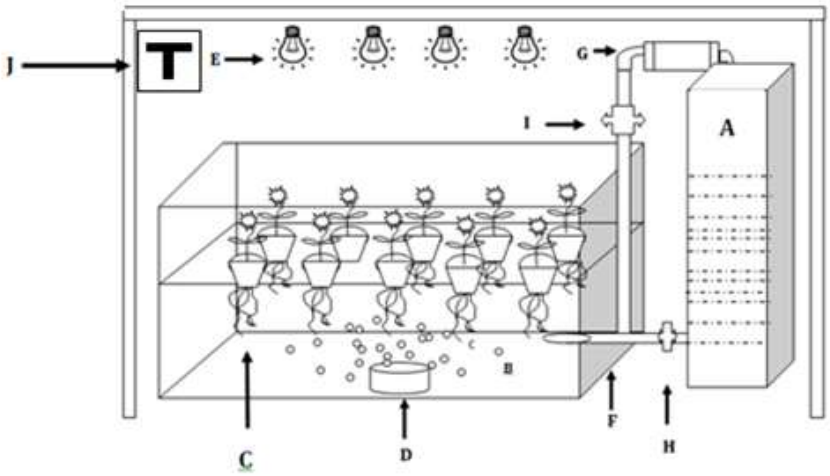
**Establishment of Hydroponic System:** Design of the Hydroponic System has been proposed below following reviewing different types of designs used by various authors (Ortiz, *et al*., 2009; Kratky, and Bowen, 1988).

**Fig. 1: Nutrient Film Technique (Nutrient Circulatory System)**




A. Main Reservoir
B. Secondary Reservoir
C. Plants
D. Aerator (Oxygen)
E. Light source
F. Nutrient In
G. Nutrient Out
H. Valve 1
I. Valve 2
J. Thermostat (T)

Many more types of scientific equipment can be used to maintain favorable environmental factors according to the need of selected plant species i.e. Air conditioners, Boiler, Water distillation unit, Water pump for liquid nutrient supply in large scale etc.

Climate change: Climate change results into change in temperature, light intensity, relative humidity etc. Optimum values of climatic factors are essential for plant survival and growth. Slight change in optimum values can cause heavy damage to plant body and its parts which can be consequence into plant decease. In this article we are discussing the role of mentioned environmental factors and the relevant case studies. Changing climate is one of the major challenges for developing countries, like India, Bangladesh, Pakistan, Srilanka and others. Lack of sources and resources for irrigation, pest management, herbicides/weedicides, and presence of hostile environmental factors and various types of soil/ water borne diseases are the prominent banes of Indian agricultural practices. The effects of all these factors can be over ruled by the new technique of agriculture – the hydroponics. Literature survey on hydroponics revealed that this technique is free from indoor/ outdoor limitations. It can be practiced/ initiated both in indoor as well as outdoor environment. (Rosenzweig, 2002; Asha, *et al*., 2012; Wani, *et al*., 2013).

Light is an important factor for plant growth. Light intensity controls the rate of plant growth. Photosynthesis or photorespiration is the two important aspects of the plant growth without which plant survival is not possible. Optimum range varies with the plant species. Hence, it is not possible to control light intensity in natural condition, which can be harmful for the plant if fluctuated above and lower than the optimum value. In

indoor type hydroponic system light intensity and time interval can be easily controlled. Optimum value of light intensity and proper time duration enhance the plant growth rate and productivity also. It is well known subject that plant growth is affected by the light spectra.

Optimum light intensity was achieved from maintaining common range of color spectra. Earlier, it has been demonstrated that red (600-800 nm) and blue light (380-480 nm) are most favorable for plant growth (Caruso, *et al*., 2011). In the present study, light spectra from 400 to 700 nm were supplemented through LED on hydroponically cultivated selected shrub. Photosynthetically active radiation, often abbreviated as PAR, designates the spectral range (wave band) of solar radiation from 400 to 700 nm that photosynthetic organisms use to optimize the process of photosynthesis. During the experimentation neutral photoperiod of about (LD 12:12) was preserved (Carre, 2001; Martineau, 2012; Thomas, 2006).

Decrease or increase in the value of annual rain fall and temperature are major unenthusiastic factors for the total agricultural productivity. For most of the plant species optimum temperature ranges from 10°C to 35°C. Optimum temperature may also be useful for enhancing physiological concert and biochemical changes in the plant body. Maintaining optimum temperature for fixed time duration according to the need of plant species, may results essentially into optimistic final productivity. Due to effect of drought in the crop of Sorghum, Maize, Tur, Groundnut, Wheat, Onion, Cotton loss in total productivity in India was reported earlier (Asha, *et al*., 2012; Wani, *et al*., 2013; Mahato, 2014; Rosenzweig, 2002). Humidity is also a major environmental factor controls the rate of plant growth. In natural atmosphere range of humidity also fluctuates with the total water content in air depending upon temperature, annual rainfall etc. High humid atmosphere is more appropriate for most plant species. Somehow few plant species are well adapted for low humid environment.

Grazing: In developing countries lack of techniques for preservation of field crops by the animals is a serious problem. Unavailability of boundary wall, shed and proper casing around the growing crops attracts birds, insects and animals for grazing. Prevention of the matter needs lots of man power and financial assistance. Plant is basic nutritional source for herbivores. Especially domestic animal lives in human society are major threat for grazing agricultural fields cultivated with green leafy crops. Many vegetable crops are devastated by cattle and other animals. To prevent such issues we can use indoor hydroponic system for herb, shrub and climber varieties of the vegetable. Concluding result may attain increase in the productivity.

Insects: According to literature reviewed loss of crop productivity by insect feeding is significant. Some of the insect resistant plant varieties have been created through biotechnology and molecular biology but very less in number. Insect feeds on plant leaf, bark and root also. They use plant as shelter by digging holes in the branches. They also lay egg, which grows into young ones to feed again the same or different plant body. Oerke, (2006) stated that risk of crop losses due to pest, weed and pathogen is remarkable in field crops at global level. Oliveira, *et al*. (2013) reported loss of agricultural productivity in their research study because of insect/pest in Brazil. Yadav, and Kumawat, (2013) assessed loss of agricultural productivity in *Solanum melongena* Linn. Due to insect pest They also identified pests sp. As *Amrasca biguttula biguttula*, *Bemisiatabaci* and *Leucinodes* or *bonalis* Guen. So many other studies are performed earlier, proving the role of insect and pest for crop destruction. On the other hand indoor environment provided by exercising Hydroponic technique may be plateful for prevention of insect pest effect. One more issue relevant to insect and pest management is use of harmful insecticides and pesticides is important to be discussed. Chemical composition of insecticides and pesticides are proven scientifically as extremely harmful for humankind.

**Microbial diseases:** Influence of biotic environmental stress is significant among field crops. Complete prevention of microbial diseases among crops is a very difficult task because not only soil but also water and air is also a main source of microbial contamination. In hydroponics we can only avoid use of soil but water, air and sunlight is essential for plant growth. But some instance we can minimize assault of microbial population. Decrease in annual productivity. Other than higher animals responsible for grazing agricultural crops fungi, bacteria, viruses, nematodes etc. are also some common biotic factor for loss in annual productivity of the crops (Wafaa, *et al*., 2015).

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Some common soil born microbial diseases found in vegetable crops used as dietary component all over the world is described by Sullivan, (2004) in his article are Fusarium rot in Asparagus, Root rot in Bean, Clubroot and Blackleg in Cabbage, Root rot and Fusarium wilt in Peas, Blackrot in Pumpkin, Clubroot in Radish. Viral diseases are most common among the plant. Viral infections also depend upon outdoor climate. It is very difficult to prevent viral infection but it can be slow down by controlling environmental factors responsible for enhancing viral infection. A useful list of soil borne pathogen accounted by Koike, *et al*. (2003) along with the name of crop, disease, pathogen, symptoms and examples of management is enlisted. This may give a succinct idea about magnitude soil removal from agricultural techniques.

**Table 1: Some worldwide cultivated crop species effected by disease causing biological agent.**

| **Plant Family** | **Plant Sp.** | **Disease** | **Scientific Name** | **Pathogen Type** |
|---|---|---|---|---|
| Apiaceae | Carrot | Bacterial soft | *Erwinia carotovora, E chrysanthemi* | Bacteria |
| | | Cavity spot | *Pythium violae* | Fungi |
| | | Cottony rot | *Sclerontinia sclerotiorum* | fungi |
| | | Crown rot | *Rizoctonia solani* | Fungi |
| | | *Phytophthora* root rot | *Phyophthora* species | Fungi |
| | | Root dieback | *Pythium* species | Fungi |
| | | Root knot nematode | *Meloidogyne* species | *Nematode* |
| | | Southern blight | *Sclerotium rolfsii* | Fungi |
| | | Crater spot | *Rhizoctonia solani* | Fungi |
| | | *Fusarium* yellows | *Fusarium oxysporum f.* sp. *Apii* | Fungi |
| | | Pink rot | *Scleroinia sclerotiorum* | Fungi |
| Asteraceae | Lettuce | Anthracnose | *Microdochium penattonianum* | Fungi |
| | | Big vein | *Mirafiori lettuce virus* | Virus |
| | | Bottom rot | *Rhizoctonia solani* | Fungi |
| | | Corky root | *Rhizomonas suberifaciens* | Gram-negative bacterium |
| | | *Fusarium* wilt | *F. oxysporum f.* sp. *Lactucum* | Fungi |
| | | Lettuce dieback | *Lettuce necrotic stunt virus* | Virus |
| | | Lettuce drop | *Sclerotinia minor* | Fungi |
| | | Lettuce drop | *Sclerotinia sclerotiorum* | Fungi |
| | | *Verticillium* wilt | *V. dahliae* | Fungi |
| Brassicaceae | Cole crops | Bottom rot | *Rhizoctonia solani* | Fungi |
| | | Cyst nematode | *Heterodera* species | Nematode |
| | | *Fusarium* yellows | *Fusarium oxysporum f.* sp. *conglutinans* | Fungi |
| | | *Phytophthora* root rot | *Phytophthora megasperma* | Fungi |
| | | *Verticillium* wilt | *Verticillium dahliae* | Fungi |

| | | | | |
|---|---|---|---|---|
| | | White mold | *Sclerotinia sclerotiorum, Sclerotinia minor* | Fungi |
| | | White rust | *Albugo candida* | Fungi |
| | | Wirestem | *Rhizoctonia solani* | Fungi |
| Chenopodiaceae | Spinach | Damping-off | *Fusarium oxysporum Phythium* species *Rhizoctonia solani* | Fungi |
| Cucurbitaceae | Cucumber | Charcoal rot | *Macrophomina phaseolina* | Fungi |
| | Melons | Damping-off | *Pythium* species, *Rhizoctonia solani* | Fungi |
| | Squash | *Fusarium* wilt | *F. oxysporum f.* sp. *Melonis (musk melon), F. oxysporum f.* sp. *Niveum (watermelon), F. oxysporum f.* sp. *cucumerinum (cucumber)* | Fungi |
| | | Melon vine decline | *Monosporascus cannonballus* | Fungi |
| | | Root knot nematode | *Meloidogyne* species | Nematode |
| | | Sudden wilt | *Pythium aphanidermatum* | Fungi |
| | | Ashy stem blight | *Macrophomina phaseolina* | Fungi |
| | | Damping-off | *Pythium species, Rhizoctonia solani* | Fungi |
| | | *Fusarium* root rot | *Fusarium solani f.* sp. *Phaseoli* | Fungi |
| | | Root knot nematode | *Meloidogyne* species | Nematode |
| Liliaceae | Alliums | Damping-off | *Pythium species, Rhizoctonia* species | Fungi |
| | | *Fusarium* basal rot | *Fusarium oxysporum f.* sp. *Oepae* | Fungi |
| | | Pink root | *Phoma terrestris* | Fungi |
| | | Stem & bulb nematode | *Ditylenchus dpsaci* | Nematode |
| | | White rot | *Sclerotinum oepivorum* | Fungi |
| | Asparagus | *Fusarium* wilt | *Fusarium oxysporum f.* sp. *Asparagi* | Fungi |
| | | *Phytophthora* crown and spear rot | *Phytophthora* species | Fungi |
| Solanaceae | Pepper | Dampiing-off | *Phytophthora* species | Fungi |
| | | | *Pythium* species | Fungi |
| | | | *Rhizoctonia solani* | Fungi |
| | | *Phytophthora* root rot | *Phytophthora capsici* | Fungi |
| | | *Verticillium* wilt | *Verticillium dahlia* | Fungi |

| | | | | |
|---|---|---|---|---|
| | Potato | Black dot | *Colletotrichum atramentarium* | Fungi |
| | | Charcoal rot | *Macrophomina phaseoli* | Fungi |
| | | *Fusarium* dry rot | *Fusarium sambucinum* | Fungi |
| | | Leak | *Pythium* species | Fungi |
| | | Pink rot | *Phytophthora erythroseptica* | Fungi |
| | | Powdery scab | *Spongospora subterranean* | Cercozoa (Protists) |
| | | *Rhizoctonia* canker (Black scurf) | *Rhizoctonia solani* | Fungi |
| | | Root knot nematode | *Meloidogyne* species | Nematode |
| | | Silver scurf | *Helminthosporium solani* | Fungi |
| | | *Verticillium* wilt | *Verticillium dahlia* | Fungi |
| | | White mold | *Sclerotinia sclerotiorum* | Fungi |
| | Tomato | Damping-off | *Phytophthora* species, *Pythium* species, *Rhizoctonia solani* | Fungi |
| | | *Fusarium* foot rot | *Fusarium solani* | Fungi |
| | | *Fusarium* wilt | *Fusarium oxysporum f.* sp. *Lycopersici* | Fungi |
| | | *Phytophthora* root rot | *Phytophthora* species | Fungi |
| | | Root knot nematode | *Meloidogyne* species | Nematode |
| | | *Verticillium* wilt | *Verticillium dahaliae* | Fungi |
| | | White mold | *Sclerotinia sclerotiorum* | Fungi |

Koike et al. (2003) accounted list of various microbial diseases along with the name of crop, disease, pathogen, symptoms and examples of management.

**Some imperative points of Hydroponics**

1. Reduced dependency on climatic factors such as light, temperature and humidity.
2. Low land area with high mass productivity.
3. Reduction in soil born microbial and viral diseases.
4. Reduction in insect growth, helps to prevent use of harmful insecticides
5. Indoor hydroponical system helps to avoid productivity loss due to grazing.
6. Less water requirement: solution for irrigation.
7. There is no space for weed. Hence, prevention of use of weedicides.

**Limitation**

1. This new emerging technology is not suitable for the crops like rice, wheat etc. in which large field area is required.
2. This technique is most suitable for small herb, shrubs and climbers. Cultivation of trees and tall plants are not easy in hydroponics.
3. Proper knowledge and continuous safeguarding is required.
4. First time investment cost is higher than the cost of traditional technique.

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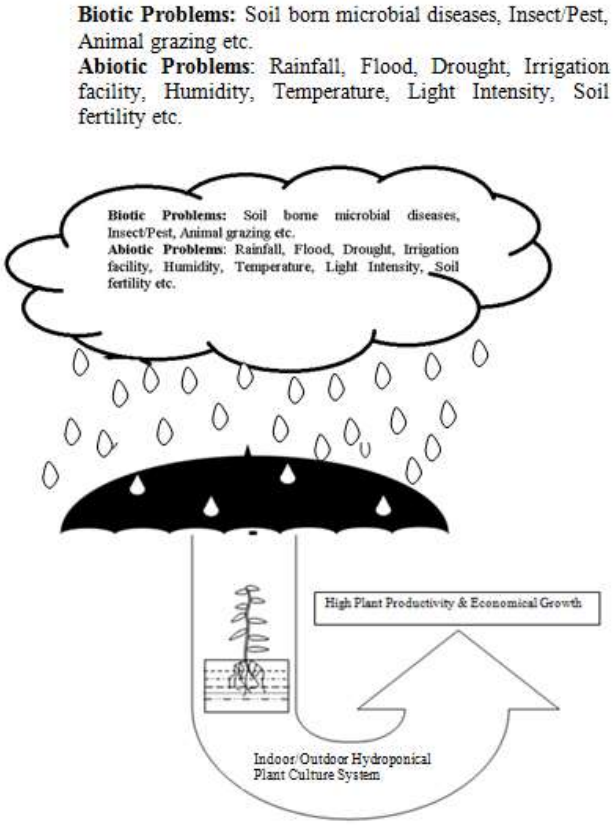
5. Setup requires some scientific equipment and handling knowledge.

**Fig. 2: Showing aspect of Hydroponical Plant Cultivation Technique**




**Future aspects**

Future aspects from the mentioned technique are really very high. Pharmaceutical industries are facing problem of continuous supply of medicinal plant and their products. Many herbs and shrubs are known for their medicinal properties can be easily grown by hydroponic without altering their biochemical composition. Green house facility prevents the supply of plant and their product in specific season. In controlled environment we can cultivate plant throughout the year.

According to literature reviewed one of the best future aspects associated with hydroponics is space technology. It is well known practice that the space mission includes a long term accommodation at space station. It is really a big trouble to carry plenty of food products with many numbers of people in single spacecraft. Spoilage and maintenance of food product is also a significant problem in space missions. Hence, the scientists are trying to find out some substitute. Theoretically in place of large mass of food product, it is easy to carry seed and nutrients dissolved in water. Cultivation of plant, utilization and release of waste material in space eradicate burden from the spacecraft. We can reduce burden of weight in spacecraft in both the ways i.e. departure and arrival.

Indoor home gardening may be encouraged by this unique technique of horticulture. Many ornamental plant species are used to grow in indoor atmosphere frequently by the people. But the knowledge of plant cultivation with nutrient water medium will encourage them to cultivate economically important plant species. Not at very large scale but somehow slight load from the shoulder of farmer would be condensed inside home environment of the society.

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**SUMMARY**

Nothing is perfect in our society. By the means of the time everything has to be change or modify itself. Old things are replaced by new things. Similarly, necessity is the mother of invention. Hence, necessity states that there should be change or modifies in old agriculture techniques to fulfill the requirement of growing world population. Difficulty with decreasing land area must be short out immediately for current and future generation. Hydroponics is a technique showing some possibility toward food security for next generation. Still there are lots of difficulties and limitation in this road of success. We does not support or encourage barely this technique but also other possibilities are welcome if they are able to overcome the requirements.

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