# DEVELOPMENT OF TRANSPLANT PRODUCTION IN CLOSED SYSTEM PART I

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## ABSTRACT

It is fundamental to control individual condition of every seedling. Automatic individual control is used by data control and analysis at on-line. As a result the best condition system was build without all waste. This system uses one of new technology irrigation system. This irrigation system supply accurate quantity of nutrient solution in the shortest time. The system named the upward injection irrigation system. First of all it is necessary to be considered whether the soil is proper or improper for upward injection irrigation system. It is important that root absorb nutrient solution as fast as possible. The ability of spreading, storing water, contamination of environment and cost were considered when choose the medium. The soil of organic culture is developed recently. The soil consists of paper pulp and vermiculite. The new soil is more suitable than ordinary medium for growing plant because this medium is made of paper pulp. The ability of store and spread of water is it's feature. We can make paper tray of this paper pulp's raw material. It is possible that pulp tray replaced plastic tray. The original plug tray of growing seedling system can make which consist of pulp medium and pulp tray. In this study, it was examined whether the plug seedling of paper pulp medium grow with upward injection irrigation system in this seedling plant system. At the same time, examine ability of store and spread of water and how to grow plant on the paper pulp medium.

Keywords : Tow-layer medium   Upwrad injection

### 1. INTODUCTION

LISA (Low-Input Sustainable Agriculture) program was launched to reduce the use of off-farm inputs with the greatest potential to harm the environment or the health of farmers and consumers (Hess , 1991). This is one of the operational definitions of sustainable agriculture. However, LISA has not gained appreciable support from the agricultural sector, since LISA decreases profits. On the other hand, the implementation of Precision Agriculture (PA) has been embraced (Blackmore, 1999). The difference between PA and LISA is that PA requires technological innovation, whereas LISA always involves revising or improving traditional practices. The extensive application of information technology, including GPS and GIS, to agriculture, and the development of agricultural machinery for PA are major factors in the difference between PA and LISA. The machinery includes equipment to implement variable rate technologies, and vehicles specifically designed to gather the information required to generate yield and soil maps.

The open field agricultural system is a typical example of a large-scale complex system that has attracted the attention of researchers and scientists in various scientific and engineering fields. Now PA promises to handle such complex systems, and has received significant support from both agricultural and industrial sectors. Although a plant factory is also a large-scale complex system, it is much less complex than an open field system. There are quite a few plant factories operating commercially in Japan. PA is nothing but integrated technology, designed to optimize the cultivation process. The fully controlled environment of a plant factory can be considered an ideal cultivation system in terms of alternative agriculture. Most of the environmental factors in a fully controlled plant factory are observable and controllable; a plant factory can be optimized more easily than an open field. This paper proposes using microprecision agriculture in a fully controlled plant factory. Microprecision agriculture can be attained by using plant factories to realize profitable alternative agriculture. This article reviews the scientific and technological achievements of plant factories as alternative agriculture, and introduces a hardware system developed to implement microprecision agriculture in a plug seedling production factory.

The aim of this study was to construct a new system to supply high-quality plug seedlings. Its ultimate goal is to produce healthy virus-free seedlings. The seedling is grown in a sterile environment with artificial light. A new technology that is economical in terms of energy, technology investment, and operating costs was used to produce seedlings rather than using conventional means, although it is difficult to pursue new technologies before reconsidering conventional methods. The goal of this study was to construct a new system suitable for producing seedlings.

## 2.MICROPRECISION TECHNOLOGY

A closed fully controlled plant-growing factory is much more advantageous in terms of minimizing wasted. Limits and the optimum design concepts have to be applied in order to establish an economically feasible, fully controlled, plant-growing factory. To achieve this objective, microprecision technologies must be developed. Microprecision does not mean a higher order of engineering precision. Microprecision in agriculture is the technological means to first identify what is needed and how much is needed as precisely as possible, and then to perform the job required to fulfill the identified quantitative and qualitative needs as precisely as possible. Microprecision technologies involve sensing, modeling, control, information, and mechatronics for plant production. Basic microprecision technologies are already available; they are SPA (Speaking Plant Approach to environmental control), AI (Artificial Intelligence: expert systems, neural networks, genetic and photosynthetic algorithms, etc.), bioinstrumentation, non-invasive measurement, biomechatronics, and biorobotics (Hashimoto and Nonami 1992).

## 3.MICROPRECISION IRRIGATION SYSTEM

This section introduces an example of microprecision technology that has actually been implemented in a plug seedling production factory. A microprecision irrigation system was developed for a plug production system. It is a kind of variable rate technology for precision agriculture. The traditional irrigation method for plug production is overhead watering, which provides growing plug seedlings with excess nutrient solution. In the traditional system, some of the irrigated nutrient solution is absorbed by the substrate (soil) and then taken up by the plant, some stays on the leaf surface, and the rest falls to the ground. It is wasted. This has been a major drawback of using the traditional irrigation method in plug production, both economically and environmentally.

## 4.1.IRRIGATION CONCEPT

The seedling should be irrigated with only the proper amount of water (nutrient solution) for the particular plant, delivered to the developing roots. This concept assures the minimization of wasted irrigation water and does not leave a residual solution on the leaf surface. No recycling of the nutrient solution is considered, since there is no excess nutrient solution. Therefore, the water (nutrient solution) must be supplied from the bottom of the cell.

## 4.2. DESIGN CONCEPT

The nutrient solution should be injected directly into the substrate (soil) where the roots develop, so that the leaves are not moistened by the irrigating solution. The nozzle for water injection should be inserted from the bottom of a plug cell, therefore the cells must have an appropriate-sized hole in the bottom. The injection process should be completed as quickly as possible, since a very large number of seedlings has to be irrigated. Leakage of solution from the cell should be avoided or at least minimized during and immediately after injection.

## 4.3. IRRIGATION SYSTEM

The irrigation device is mounted on a multi-functional shifter that can both position a cell tray on the irrigation device and weigh each cell tray before and after irrigation, to monitor the amount of water used or evaporated from the cell tray. Many cell trays are stored vertically in a two-dimensional array. The irrigation unit can move the irrigation device to the location of each cell tray requiring irrigation. Irrigation scheduling and operation should be controlled by computer. The irrigation unit is mounted on the transport equipment which can position the irrigation device precisely under the plug tray which is to be irrigated .

## 4.4. IRRIGATION DEVICE

A microprecision irrigation device was developed. The device was designed to fit a 300 x 600 mm cell tray containing 72 cells. The solution is discharged from 72 nozzles fixed on an aluminum plate, which can be moved up and down. It is actuated by a ball screw hooked to a servomotor, which controls the vertical position of the injection nozzle tip relative to the interior of a plug cell filled with a substrate (soil mass) and roots. The amount of solution discharged from each nozzle is regulated by the time that a solenoid valve connected to the nozzle remains open. Seventy-two solenoid valves are controlled individually, so that the amount of solution discharged from each nozzle can be varied as required. This can be considered as a variable rate technology such as those highlighted in PA. Figure 1 shows the irrigation device a schematic diagram of its mechanism.

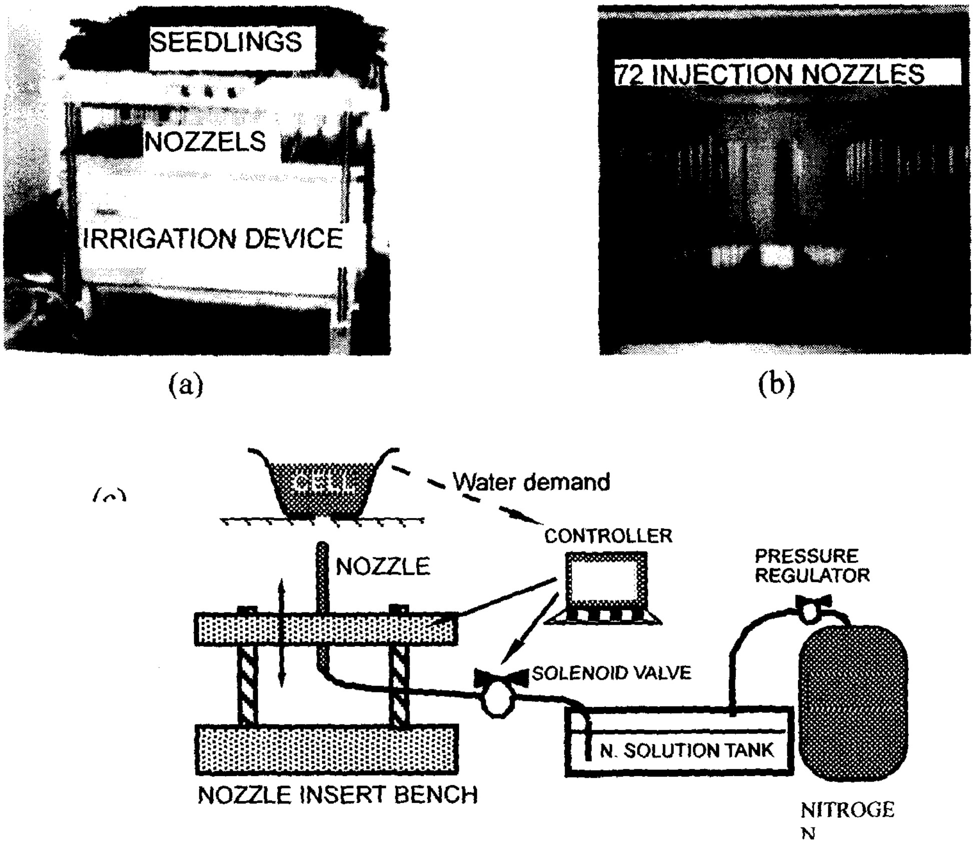


Fig. 1. Pictures (a,b) of irrigation device and a schematic representation of the device mechanism(c)

## 5.CELL TRAY AND MEDIUM

Fundamental to our goal is the need to control individual conditions for every seedling. Automatic individual control requires data control and on-line analysis. Consequently, we built an optimal system using a new irrigation system, called the upward-injection irrigation system, which does not produce waste. This irrigation method supplies an accurate quantity of nutrient solution very quickly. The system produces high-quality seedlings locally for global distribution. The cell tray is an important part of the system and specific to the upward injection irrigation system. A sterilized tray is used to prevent contamination, and discarded after one use. This system does not require nutrient medium because the seedling is grown in nutrient solution.

First, it is necessary to consider whether the soil used is suitable for the upward injection irrigation system. The root must absorb the nutrient solution as quickly as possible. The ability to spread and store water, environmental contamination, and cost were considered when choosing the medium. We used organic culture soil, which was developed recently and consists of paper pulp and vermiculite. This soil is more suitable for growing plants than ordinary medium because it is made of paper pulp, which allows water storage and spread.

We can also make paper trays from paper pulp and these may replace plastic trays. Our seedling system used pulp medium and trays. This study examined the growth of plug seedlings in paper pulp medium using the upward injection irrigation system in our seedling plant system. It also examined the ability of the paper pulp medium to store and spread water

## 6.EXPERIMENTAL METHOD

Figure2 shows the experiment method. sweet potato was grown in paper pulp medium. Growth of leaves was observed after 20 days in the medium at a temperature of 30°C, 80% humidity, a light intensity of 250 $molm^{-2}s^{-1}$, and a light interval of 12 hours. The length, width, fresh weight, and number of leaves were measured in 200 seedlings. Each seedling was supplied with 15cc nutrient solution once a day. Seedlings were grown in soil for comparison.

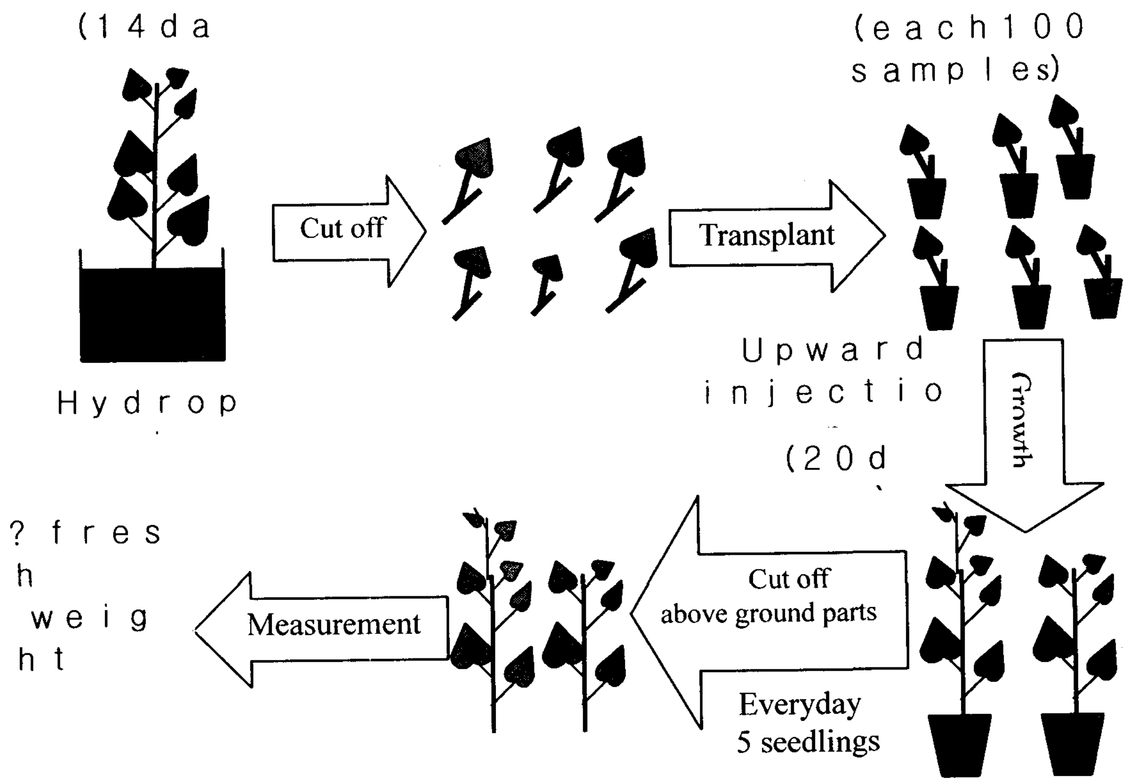


Figure.2.Experimental method schematica

## 7.FFECTS AND CONSIDERATIONS

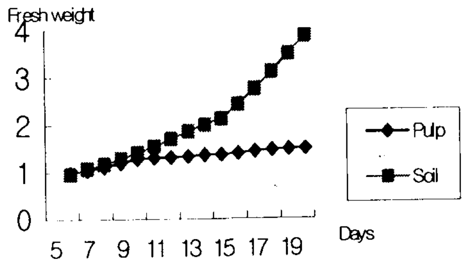


Figure 3 shows seedling growth indicated by the average fresh weight and number of leaves. There was a significant difference between soil and the paper pulp medium. Seedlings grown in the pulp medium gained 40% less weight than seedlings grown in soil, while they had half as many leaves. This is why this paper pulp medium is not used for vegetables. The paper pulp medium is good at spreading water, but soil is superior for rooting leaves. In the future, we hope to develop a two-layer medium that combines the advantages of the two. Figure4 illustrates the two-layer medium schematically.

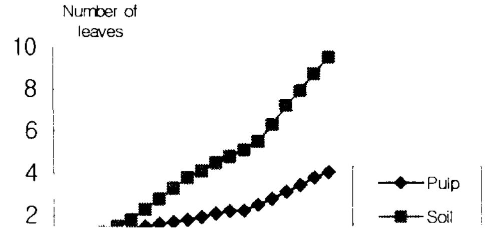

Figure 3. Influence of medium on growth

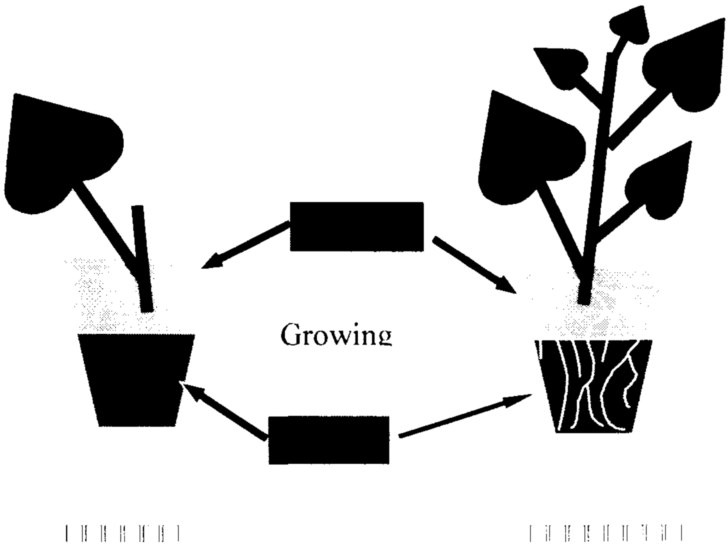


Figure4. two-layer

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