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Research Article

# MODERN NURSERY RAISING SYSTEMS IN VEGETABLES

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**Abstract-** Raising healthy seedlings under good nursery management practices is an important part of successful vegetable production. Seedling tray technology was developed for the efficient production of high-quality seedlings for transplanting. The technology was introduced into Korea in 1992, and has now become an important industry. Modern technologies are important mainly for the mass production of vegetable seedlings, which were transplanted into greenhouses or the open field. The quality of the growing media used in seedling tray is largely influenced by physical, chemical and biological properties of the growing media. The main purpose of raising seedlings in protected structure is to produce quality and disease-free seedlings in off season to raise early crop in protected condition or open field condition to get higher profit.

**Keywords**- Seedling tray, Media, Protected structure, Quality seedling production.

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## Introduction

Healthy seeds and seedlings are the first and essential requirement for achieving full yield potential of any vegetable crop. In recent years, vegetable growers have become highly conscious of the importance of quality seeds or seedlings. A major portion of the area under vegetable cultivation in India is now sown with hybrid seeds, which are costly but give higher yields and quality produce. In view of the high cost of seeds, some vegetable crops like tomato, brinjal, capsicum and cucurbits are being transplanted after growing nursery under protected conditions to achieve maximum germination count and healthy plant establishment. Raising of seedlings in plug trays or portrays is one such technology that achieves the above requirement. This technology is fast emerging as agro enterprise in India for its obvious advantage to both the nursery grower and the farmer. Soil-less substrate consisting of coco-peat and vermiculite is commonly used in seedlings trays and one seed is manually placed in each cell of the seedling tray and covered with media. However, manual seeding is labour-intensive, time consuming and required more labour for cultural operation. Mechanized precision seeding of seedlings trays is, therefore, necessary to enhance the capacity of rapidly growing nursery industry in India.

## Importance of hi-tech vegetable nursery production

- Development of entrepreneurship in rural areas
- Development of related small scale input industries
- Employment generation especially for rural women
- Waste utilization – Coconut Coir pith
- Mechanization is possible, hence reduction in drudgery of farm workers
- Nursery men can also act as techno agent in spreading of technologies like improved varieties and hybrids
- Less loss of expensive seeds
- Proper seed germination, uniform growth, least seedling mortality
- Least pest and disease incidence

**Table-1** *Yearly demand of vegetable seedlings and seeds in India*

| S.No | Crop | Seedling(millons) | Seed(kgs) |
|---|---|---|---|
| 1. | Tomato | 13028 | 600 |
| 2. | Brinjal | 200000 | 635 |
| 3. | Chilli | 14157 | 195 |
| 4. | Onion | 695000 | 2779 |
| 5. | Cabbage | 22963 | 101 |
| 6. | Cauliflower | 12669 | 87 |

(Source: *Resource Book on Horticulture Nursery Management, NAIP, ICAR, 2012*)

## Components and process involved in modern nursery raising system

Seedling tray, media, machanization, irrigation, nutrients, protected structure, light and seed pelleting and priming, biological enhancement and hardening.

## Seedling tray

Choice of tray cell size (number and volume) to grow seedlings depends on several factors, including seed size, economics, plant growth rates, and customer demands. Cell number varies from 72 to 800 cells per standard tray (53.7 X 27.5 cm) [2]. Cell size can vary by both the diameter (round cells) or size-length (square cells) and depth of the cell. Cell size is more important, which controls the amount of media used as well as water holding capacity. It is less expensive on per plant basis to grow and ship a small volume cell than a larger one. The smaller the cell size dimensions in the tray, the more units a grower can produce per unit area since seedlings will finish faster and more seedlings can grow per unit area in the greenhouse space. Seedlings grown in larger cells are taller and have greater dry weight than those grown in small cells [3, 4]. Tomato, brinjal, capsicum, chilli, watermelon, broccoli, cauliflower [3], cabbage [5], onion [6] and muskmelon [7] were reported to have earlier yields and more rapid early transplant growth when grown in larger cells. A container size increases root and shoot biomass is increase [8]. If root volumes are reduce, water and nutrient uptake might likewise be reduced, thus leading to decreased shoot size.

**Table-2** *Difference between field grown seedlings and container grown seedlings*

| S.No | Traditional method of seedlings raising (Grown under open field condition) | Modern method of seedlings raisings (Grown in plug trays under protected condition) |
|---|---|---|
| 1. | More seeds required for raising seedlings. For example hybrids seeds 100g per acre required for tomato. | Less seeds required for raising seedlings compared to traditional method. For example hybrids seed 70g per acre required. |
| 2. | Disinfect the nursery area by solarization. | Use clean trays. |
| 3. | Prepare seed beds about 3m X 1m in size and 20 cm heights. | Use the correct cell size according to the crop. For example, cucurbit crops require larger cell size than other vegetable crops. |
| 4. | Prepare the nursery bed soil loose and friable and sow seed in lines about 5 cm apart and 1-2 cm deep. Adjust the planting depth according to the seed size. | Prepare growing media: normally coco peat mixes with bio-fertilizer were used. Sown one seed in each cell at a depth of 0.5 to 1.0 cm. |
| 5. | Cover the nursery bed with paddy straw or dry leaves for germination. | Cover the trays with black polyethylene sheet for germination. |
| 6. | More loss of expensive seeds | Less loss of expensive seeds. |

Singh and peter [1]

### Media

Media is one of the important components for modern nursery raising system. Successful nursery production is largely dependent on the chemical and physical properties of the growing media. Physical characteristics of the media are important for water and nutrient holding capacity as well as proper aeration for optimum root growth. Both physical and chemical components of media are most importance for optimum shoot and root growth. Choosing a media for seedling production also must be based on economic considerations. Costs for media may optimize plant growth, but costs for the products may not be economically viable. Cell volume then becomes as key economic factor with regard to the quantity of media required to grow the seedlings. Additionally, small cell volumes can create problems with moisture retention, aeration and soluble salt buildup. The type of irrigation method will also dictate media decisions.

A growing media must be sterile and may or may not be inert, but it should have cation exchange capacity (CEC). The CEC is associated with pH and nutrient buffering capacity [9]. For this reason, many seedling production operations use peat as a major part of media makeup. On a weight basis, the CEC of sphagnum peat is about nine times that of a loamy mineral soil. However, due to the low bulk density of the peat, the effective CEC is lower than that of mineral soil. The ratio of water to air held in the media is controlled by particle size and pore space distribution [10]. Capillary pores (< 0.3 mm) retain water after irrigation, while non-capillary pores (> 0.3 mm) provide root aeration [11]. Thus, it is important to provide an adequate mix of both capillary and non-capillary pore in the media.

Coco peat is a byproduct of extraction of fiber from coconut husk. It is 100 percent natural, biodegradable, fibrous and spongiest material. It has high C: N ratio, therefore it takes long period to decompose. Also it has high water holding capacity, approximately seven to nine times its own weight. Coco peat contains antifungal and antibacterial properties. In addition, it contains high CEC and moderately high pH value. Considering above properties, Coco peat is very good plant growth substrate, after adjusting several properties in soil less cultivation such as green house vegetable nurseries.

### Seed pelleting and priming

Many vegetable seeds that are sown for seedling are small or big and irregular shaped. Most commercial seedlings producers use drum vacuum seeders thus, these types of seeds should be pelleted or coated. Pelleting builds up seed size and uniformity by layering the seed with layers of clay type material and binder. Seeds normally pelleted include tomato, brinjal, chilli, onion, lettuce and celery. Seed coating is accomplished by applying wet solutions containing a dye and many times fungicides or other chemical treatments. The coating does not build up seed size, nor does it change the shape of the seed. The coating makes the seeds more flowable in the seeders. Species that are commonly coated include cucumber, watermelon, squash and melon. Using dyes in the coating or pelleting process allows the seeds to be more visible at sowing [8].

### Biological enhancement

Seed treatment is a most common method adopted for healthy seedlings production. The seed treatment is an effective and economic method. Treat the seeds with Trichoderma viride 4 g or Pseudomonas fluorescens 10 g or Carbendazim 2 g per kg of seeds 24 hours before sowing. Just before sowing, treat the seeds with Azospirillum @ 40 g / 400 g of seeds. Mix sterilized cocopeat @ 300 kg with 5 kg neem cake along with Azospirillum and Phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protray.

### Mechanization

The transplant tray is the first area that facilitates mechanization both in seedling and potentially automatic field transplanting [12]. Essentially all seedling transplant operations have mechanized the seeding process [13]. Trays are loaded in bulk onto a line where they are filled with media, dibbled, sown via a vacuum drum seeder, topped with vermiculite, watered and then stacked by hand. Operators have to inspect the line, stack trays to fill, and stack the filled flats as they come off the line. This process is enhanced if the seeds are pelleted, round and of reasonable size. More sophisticated seedling operations use robots to load and unload flats onto benches.

### Germination

Warm temperature and uniform moisture are important for successful seed germination. Many seed germination chamber systems are commercially available including custom built germination units. Many growers use bottom heat or root zone heating to provide warm, even temperature. A weed mat (Black polyethylene) is placed on the top of the bench to help spread the heat with skirts on the side to help contain the heat. Tomato seeds germinate are best at 21$^0$C. The ideal root zone temperature is 26 to 29$^0$C during the first four weeks of growth and 20 to 26$^0$C during the fifth and sixth weeks. In brinjal seed germinate at 21 to 24$^0$C. Chilli seed germinate at 28 to 32$^0$C [1].

### Irrigation

Seedlings can be irrigated above the plants or sub irrigation via ebb and flow. The costs vary considerably. Over head irrigation usually requires a boom with nozzles, while the more expensive ebb and flow system requires concrete floors and a recycling system for the water. The advantage of the latter system is that no water is applied to the foliage of the seedling. Therefore, there is reduced potential for development and spread of diseases. Also, water and nutrients are recycled, reducing groundwater pollution, thus saving water and fertilizer. Although the type of irrigation system may alter root morphology in the seedlings, total yields of many vegetable crops are not affected by the type of irrigation [14]. Flotation systems improved uniformity of tomato and bell pepper [15]. Total root elongation was similar for both overhead irrigation and sub irrigation treatment. Sub irrigation reduced shoot to root ratio and promoted plant hardiness.

### Nutrients

Nutrition plays an important role in the nursery. The nutrition in the form of organic and inorganic sources supplies all the essential nutrients required for proper growth and development of the nursery plants. The availability of nutrients to the plant depends upon many factors such as source material, nutrient content, correct soil condition and type of fertilizer. Plant performance in nursery depends on nutrient status in plant media, but no nutrition guideline has been worked out owing to its short duration of plants with nursery. It is necessary to apply need based nutrients for quality production of seedlings. Both shoot and root mass were improved by increasing N, but the increase in shoot mass was much greater than for root mass in response to N, resulting in higher shoot to root ratios. Generally, when adequate rates of P are supplied to the growing media, little enhancement of transplant growth and performance in the field is observed when P levels are increased [16].

Apart from the N, P, K, Ca, Mg and S, micronutrients such as Fe, Mn, Zn, Cu, B, Mo and Cl are also necessary for maintaining the normal health and metabolism of plants. Nutrient deficiency leads to poor and stunted growth of plants and resulting in poor performance. Nutrient deficiency can easily be corrected by applying the deficient element either by soil application or by foliar application or by the combined application of soil application and foliar spray [17].

**Protected structure**

Poly house gives better protection, due to total avoidance of rain water entry into poly house, hence leaf diseases can be easily controlled. Transparent UV stabilized polyethylene film 200 micron thickness is used for covering the poly house roof. It is provided with retractable or movable shade nets, at about 11 feet height just below the structures from ground level. The sides of the poly house are covered with 200 micron thick polyethylene film to a height of 3 feet from the ground level, to have better protection from rain splash. Remaining height of side wall is covered with 40 micron white colored insect proof net from all the four sides.

Poly house is provided with an ante chamber with two doors constructed at opposite directions where entry or exit to the poly house is made through the first door and then after closing the first door, the second door is opened to make an entry into the poly house. Care should be taken not to open both the doors simultaneously to avoid the entry of pests into the protected structures. A small concrete trough of 2 meter length, 1 meter breadth and 2 inch depth should be prepared between the two doors of antechamber for facilitating washing legs in the disinfectant solution (Potassium permanganate) to prevent any contamination inside the poly house [18].

**Economics of raising nursery under poly house**

| | |
|---|---|
| Size of structure (10m (L) x 5m (W) x 7' (H)) | = 50m$^2$ |
| No. of seedlings 8000 (polybags) + 7000 (portrays) | = 15,000/- |
| Seedling @ Rs.2/- | = Rs. 30,000/- |
| Investment cost (polyhouse, polybags, protrays) | = 15,500 + 5,000 |
| | = Rs. 20,500/- |
| Net profit 1$^{st}$ year (30,000 – 20,500) | = Rs.9500/- |
| Net profit 2$^{nd}$ year (30,000 – 5000) | = Rs.25000/- |
| Net profit 3$^{rd}$ year (30,000 – 6000) | = Rs.24, 000/- |

Yadav *et al*. [19]

**Light**

Light is one of the important environmental factors that control seedlings growth. Light may also be used to condition seedlings before they are transplanted to more hostile environments. New photo selective greenhouse films now allow growers to alter light quality inexpensively. Improving light quality can improve the seedlings growth. Under a fixed photoperiod, seedling growth and quality was improved by increasing the photosynthetic photon flux (PPF) [20]. PPF was adjusted for all film treatments. The FR light absorbing films were effective in reducing stem elongation and producing compact tomato, bell pepper and cucumber seedlings.

**Hardening**

The term hardening refers to the process of gradually exposing seedlings to the normal climatic condition from protected condition. This is done to reduce stress and subsequent growth check when seedlings are transplanted to the main field. Hardening can be accomplished by increasing light intensity or exposing transplants under full sunlight, reducing irrigation or watering and fertilizer application.

**Pest and disease management**

- Hygiene has a vital role in the control of pests and diseases.
- Use steam or chemical sterilization of the growing media, structures, tools and trays.
- Effective ventilation and air movement is also a sound disease prevention method.
- Understand pests and diseases that could affect the growth of healthy seedlings
- Care must be taken with the use of pesticides within enclosed areas.
- Note also that in a greenhouse plants can be more sensitive to chemicals than in the open field.

**Limitations**

- Lack of trained personnel and skilled labors for doing nursery activities
- Initial establishment and maintenance cost for nursery needs to be met by the people, which they presume as a risk bearing activity
- Risk on marketing of seedlings, pest and disease damage incidences
- Transplant shock which delays growth but is not as severe on cell raised seedlings compared to bare rooted seedlings.

**Conclusion**

Vegetable nursery production has become a highly commercialized business, wherein most farmers buy their plugs from professional growers. Many factors help to produce quality seedlings. These include the use of high quality seeds, growing media with good drainage, water holding capacity, and providing optimal rates of fertility. Further, seedlings are germinated under more or less optimal conditions to obtain uniform stands and are grown in protected culture under greenhouse conditions. Rate of plant development, root structure, plant height and vegetative matter can be tightly controlled under these conditions. Container cell sizes can be adjusted to help produce plant sizes that conform to strict can be adjusted to help produce plant sizes that conform to strict customer demands. The use of robots for tray filling, in the production greenhouse, and the mechanization of both the planting and growing process, as well as fertilization of the tray and harvest process can further reduce labor requirements of the plug production system. The advent of plug transplants have allowed growers of many specialty crops the ability to greatly reduce seed costs, increase stand uniformity, and in many cases increase yields and quality of the products produced. In the future, many more crops may be grown as seedling transplants, especially those of high economic value and potentially high seed cost.

**Author contributions**

Pandiyaraj P – Collection of article, analyze the article, critical revision of the article, final approval of the version to be published and acted as corresponding author.

Rajeev Kumar Yadav – Critical revision of the article

Vijaykumar S – Critical revision of the article

Arindam Das – Critical revision of the article

**Author statement:** All authors read, agree and approved the final manuscript

**Abbreviations**

CEC - Cation Exchange Capacity

C:N – Carbon : Nitrogen

PPF - Photosynthetic Photon Flux

FR – Far Red

UV – Ultra Violet

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**Ethical approval**

This article does not contain any studies with human participants or animals performed by any of the authors.

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