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COMPARATIVE STUDY OF MEDIA MIXING AND FILLING TECHNIQUES IN HORTICULTURAL NURSERY PRACTICES

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ABSTRACT

Nursery is consequently the basic need of horticulture, high demand of ornamental plant, medicinal plant and any horticultural plants leads this business to keep expanding. Preparation of media mixture and filling the bags/containers are important operation and its time consuming and laborious tast. Labor problem such as increasing minimum wage, labor scarcity and low productivity becomes main issue in recent years. Therefore, implementing machinery to assist nursery production might solve nursery labor problem. The media mixture machine is an efficient tool that combines several operations: pulverizing, size reduction, mixing, weighing and bag filling into a single process. By performing all these functions in one pass, the machine reduces operating costs, making it more cost-effective than traditional media mixing methods. The machine-made mixture is more suitable for seedling establishment, with 82.20% of the desirable aggregate level, compared to 79.6% in the hand-made mixture. As compare to manual method, saving of operation cost per hour by media mixture machine is 62% and saving in cost/kg of media is 50%. The media obtained from machine is uniform and properly mixed which is required for better establishment of nursery sapling.

Key words : Cost effective, Media mixture, Nursery, Ornamental plants, Uniform mixing.

Introduction

Horticulture is a diverse and dynamic sector. It has vast potential and ongoing advancements, horticulture continues to contribute to India's agricultural growth, export earnings, and overall socio-economic development. It involves the cultivation of a wide range of fruits, vegetables, flowers, medicinal plants, spices and ornamental plants. India is the second largest producer of fruits and vegetables in the world. It is leading producer of several horticultural crops, namely mango, banana, cashew-nuts, arecanut, pomegranate, sapota, guava etc.

The planting materials for horticultural plantations are raised from seeds and vegetative parts. While raising grafts for each horticultural crop, the specific medium is recommended for the satisfactory growth of the plant / seedling. It is possible to manipulate the physical and chemical properties of the medium suitable for better growth of the plant. There are several types of media are available for use in propagation such as soil, sand, vermicompost, peat moss, cocopeat, rice hull etc. (Richard *et al*., 1964).

Many operations are involved in seedling production which include selection of horticultural crop followed by preparation of media mixture for the selected crop. The media mixture is filled in polythene pots/polybags of different size as per the crop requirement. A good quality of media mixture for nursery operation is free from added organic fertilizer with its pH ranging from 5.5–6.5 (Krishnan *et al*., 2014). Potting media is an important input for containerized seedling production. It is responsible for healthy and uniform seedling production. Apart from the selection of proper ingredients, it is necessary to maintain the porosity of the media mixture for proper development of root (Srivastava *et al*., 2009). There are various sizes of pots that are used in the nursery. A good potting media is characterized by light weight, friability, easy blend ability, good water holding capacity, drainage, porosity, low bulk density, free from fungal

spores and insects as well as low inherent fertility etc. (Chakrabarti *et al*., 1998).

Grower-Mixed Media versus Commercial Media

Nursery growers have the option of either mixing their own media or purchasing a commercially-formulated media. Growers who mix their own growing media has both control and flexibility. It has control over the selection of ingredients and the quality of the final product, and flexibility to choose from many media recipes tailored to specific crops, container types, etc. Growers who purchase commercially-formulated media, although more expensive, do not need to invest in mixing equipment and have the added flexibility in purchasing from suppliers who offer a diversity of media mixes.

Review of literature

Manually Media Mixing and Bag Filling

Traditionally, potting media is mixed and packed into poly bags manually. Men and women laborers typically mix the potting media using spades and fill the media into poly bags while sitting (Fig. 1). It appears that no machinery is used for mixing and filling potting media in the country. There is a lack of literature on the mechanization of potting media in Indian horticultural farms. The current manual method requires both men and women laborers, making the process not only tedious and laborious but also costly. In this method, only 300-350 bags of 500 grams can be filled in a day, which costs 1140 per 1000 bags (Kasten, 2011 and Essegbemon *et al*., 2014).

Bhatkulkar and Modak (2014) designed and prepared nursery fertilizer mixture using human powered flywheel motor. In the research a human being was used to spin a flywheel by system similar to bicycle. This energy source was conceptualized as Human Powered Flywheel Motor (HPFM). Thus, a human powered mixing machine was developed and experimentally validated to mix nursery fertilizer in proper proportion. The evolved machine system comprised of three subsystems namely (1) Energy Unit : Comprising of a suitable peddling mechanism, speed rise gear pair and flywheel conceptualized as Human Powered Flywheel Motor (HPFM) (2) Suitable torsionally flexible clutch and torque amplification gear pair and (3) a process unit (Nursery fertilizer mixer). The machine developed was economically viable, which could be used by unskilled workers and it saved time.

Fig. 1 : Manually Media Mixture and Bag Filling.

Senthil and Carolin (2016) studied the different types of growing media siever. Manually or motorized rotary screen type media siever was useful to sieve Farm Yard Manure, Vermicompost, Cocopeat, Sand and Soil to remove all the particles larger than 1.5 mm in the form of stones, clods, straw etc. The capacity of the machine is 1 tonne/ha and motorized sieve was operated by 0.5 hp motor. One person was required to feed the unsieved media and one person was required to collect the sieved material. It can also be operated manually by one labour. It can be used for filling nursery bags.

Media Mixing and Bag Filling Using Machine

Selvan *et al*. (2015) designed, fabricated, and tested a power-operated continuous-run machine for seedling-nursery management (Fig. 2). This machine can mix, pulverize, sieve and fill pot ingredients into polybags. It features a vertical, free-standing unit mounted on four legs and includes a 3-hp motor, a feed hopper, a pulverizing chamber with eight paddles, a sieving compartment with a slider-crank mechanism, electronic vending instrumentation and an outlet. Ingredients such as soil, sand, granite powder, farmyard manure, and compost are fed into the top of the machine and the potting mixture is collected at the bottom. The machine's electronic vending system is a key innovation, allowing for precise filling of the potting mixture at set quantities and time intervals. The machine produces a mixture with aggregate analysis, degree of pulverization, and other physical parameters that meet or exceed recommended levels compared to manually-made mixtures. The machine achieved a higher proportion (81.8%) of desirable aggregate levels compared to the manual method (79.5%), resulting in improved mixture quality for seedling establishment. Additionally, using the machine resulted in a 71.4% cost saving and 80.2% time saving. The machine is recommended for nursery holders nationwide, as it can produce potting mixtures for up to 30,000 saplings per month in a commercial nursery.

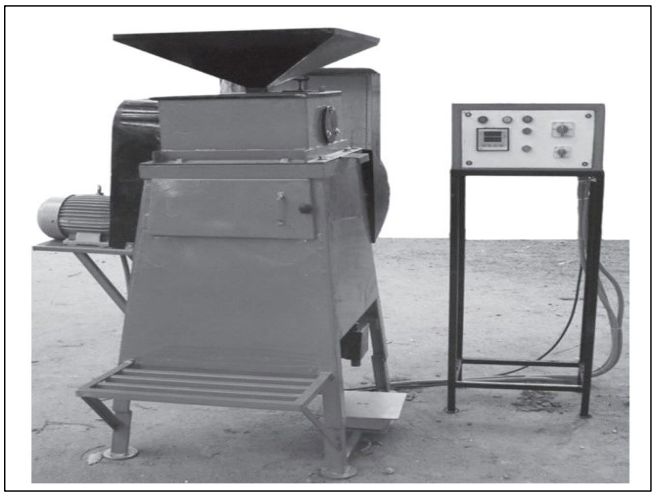
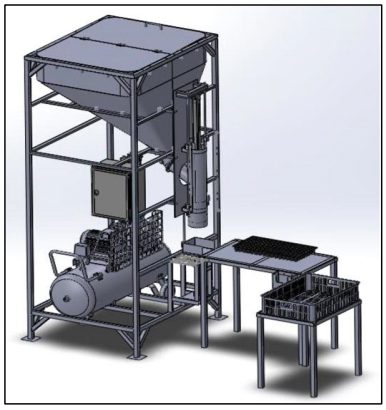


Fig. 2 : Power-Operated Continuous-Run Potting Machine.



Machine specifications

Dimension	: 1060 x 680 x 2280 mm
Capacity	: 100 bags/hour
Power	: 0.9 kW / 220 V
Working air pressure	: 6 bar
Air consumption	: 80 liter/minute

Fig. 3 : Semi-automatic plant Media Bagging Machine for Container Plant nursery.

Yulianto and Raibhu (2018) designed semi-automatic plant media bagging machine for container plant nursery to reduce the labor required and production lead time during re-planting process (Fig. 3). Observation and interview is conducted at one plant nursery for collecting user requirements. Collected user requirements, then transformed to engineering specification using house of quality matrix. Machine conceptual design is created by analyzing the current practice of re-planting and identify the function with function structure diagram. Identified function, then inserted into the morphological matrix in order to generate possible solutions for automating the function. One concept is selected to further develop into detail design. Selected machine concept is using compressed air to fill plant container with media and compress the media. This machine is capable to reduce production lead time up to half of current production process by utilizing one operator.

Hage and Dhande (2021) designed and developed media mixture machine for horticultural crop nurseries (Fig. 4). This machine is well-suited for small-scale horticultural operations and includes a hopper, a pulverizing

Fig. 4 : Media Mixture Machine for Horticultural Crop Nursery.

drum, a sieve, a mixing drum, a metering mechanism, an electric motor, and a safety guard. A 2 hp single-phase electric motor was chosen as the power source for the machine. The results from testing the media mixture machine indicate that it produces a uniform and well-mixed media essential for optimal nursery sapling establishment. The machine was found to reduce the bulk density of the media mixture while increasing both the particle density and total porosity after processing through the pulverizing and mixing drums. The media size achieved was a minimum of 1.97 mm at a feed rate of 140 kg/h. The machine consistently provided a thoroughly mixed media mixture. The metering accuracy of the machine ranged from 1.4% to 1.57% under various operating conditions and the power required to operate the machine ranged from 0.62 to 1.06 kW depending on the operating conditions.

Results and Discussion

The Results and Discussion section of a review article on various media mixing and bag filling methods would provide a comprehensive overview of the various media mixing and bag filling methods used in modern horticulture, highlighting their effectiveness, and discussing their impact on property of media, quality and overall performance as summarized in Table 1. The analysis shows that the physical and mechanical properties of a machine-made media mixture are comparable to those of a hand-made mixture and it shown in Table 2. As a result, the machine-made mixture is deemed suitable for growing seedlings. Sieve analysis results indicate that the particle size distribution of both hand-made and machine-made media mixtures is comparable (Richards *et al.*, 1986). The

Table 1 : Comparison of basic properties of media mixture.

Property		Soil + Sand + FYM (2:1:1) v/v		Soil + Granite powder + FYM (2:1:1) v/v	
		Manual	Machine	Manual	Machine
Physical	Bulk density, g/cc	1.07	1.11	1.10	1.08
	Particle density, g/cc	1.75	1.83	2.02	1.85
	Water holding capacity, %	32.4	35.3	28.4	32.6
Mechanical	Fine sand content, %	32.1	34.3	21.0	23.5
	Course sand content, %	36.6	34.2	33.0	36.6
	Silt content, %	28.2	30.6	29.6	29.5
	Clay content, %	1.5	1.7	4.5	5.2

Table 2 : Particle size distribution of pot-mixture.

Sieve opening (mm)	Cumulative weight			
	Machine filling		Manually filling	
	Weight (g)	%	Weight (g)	%
6.50	340		318	
2.00	980		980	
0.80	1565		1610	
0.50	1730	82.20	1722	79.6
0.25	1881		1812	
0.10	1950		1905	
0.00	2000		2000	

shortages and results in uneven mixing, potentially affecting seedling growth. Additionally, it is more expensive, with a cost of ` 1140 per 1000 bags (Kasten, 2011 and Essegbemon *et al*., 2014). Furthermore, manual mixing using spades lacks scientific precision and poses a risk of contamination. Using media mixture machine; pulverizing, size reduction, mixing, weighing and bag filling operations can be done at a same time resulting in saving of time and energy. The operating cost of the media mixture machine is reduced as more than two operations are performed by one pass with single machine. Thus, the machine is saves time, energy and cost as compared to the traditional media mixture methods.

Table 3 : Comparison of machine performance with traditional method.

Method	Weight of bags	No. of bags filled in a day	Capacity (kg/h)	Degree of Mixing (%)	Cost of operation	
					(Rs/h)	(Rs/kg)
Machine	500 g	2000 - 2200	125 - 140	95.00	72.60	0.80
Manually	500 g	350 - 400	20 - 25	82.50	44.85	1.20

machine-made mixture is more suitable for seedling establishment, with 82.20% of the desirable aggregate level, compared to 79.6% in the hand-made mixture and it shown in Table 2.

Conclusion

Nurseries need optimal conditions for growing fruit and vegetable seedlings, involving five primary operations: selecting horticultural crops, preparing the media mixture, filling polybags, pretreating seeds, sowing seeds and watering. The media should have excellent water holding capacity, low bulk density and be well-mixed and pulverized. Currently, the process of sieving, sterilizing, mixing and filling media into polybags is performed manually, which is both slow and labor-intensive. This manual method limits production capacity due to labor

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