www.ThePharmaJournal.com

The Pharma Innovation

**ISSN (E): 2277- 7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.23**
TPI 2021; SP-10(9): 725-729

www.thepharmajournal.com
Received: 28-07-2021
Accepted: 30-08-2021

**Hage VJ**
M-Tech Student, Department of Farm Power and Machinery, C.A.E.T., Dr. B.S.K.K.V., Dapoli, Maharashtra, India

**Dhande KG**
Associate Professor (CAS), Department of Farm Power and Machinery, C.A.E.T., Dr. B.S.K.K.V., Dapoli, Maharashtra, India

**Corresponding Author**
**Hage VJ**
M-Tech Student, Department of Farm Power and Machinery, C.A.E.T., Dr. B.S.K.K.V., Dapoli, Maharashtra, India

# Design and development of media mixture machine for horticultural crop nursery

## Hage VJ and Dhande KG

### Abstract
Preparation of media mixture was important operation in horticultural nursery. Traditionally media was mixed and filled manually in poly bags, it requires more labour and time. The labours were not available in time and hinder the nursery raising process. The media were being mixed by spade preferably by men labourers. Then women workers were filling the media mixture in poly bags in sitting posture. It was not only a tedious job with poor output, but also a laborious work. The manually mixed media does not get mixed properly and may affect the growth of seedling. To overcome above mention problem, the media mixture machine was design and developed for horticultural crop nursery. The developed media mixture machine was suitable for small scale horticulture nursery. Its consists of hopper, pulverizing drum, sieve, mixing drum, metering mechanism, electric motor and safety guard. An electric motor of 2 hp single phase rated power was selected as the power source for operating the media mixture machine.
Based on result of developed media mixture machine for horticultural crop nursery, conclusions were drawn on the basis of research work. The media obtained from machine was uniform and properly mixed which was required for better establishment of nursery sapling. It was found that bulk density of media mixture decreases whereas particle density and total porosity increases of media mixture after passing through pulverizing and mixing drum of developed machine. The size of media obtained as minimum 1.97 mm at 140 kg/h feed rate. The thoroughly mixed media mixture was obtained from developed media mixture machine. The degree of metering of developed media mixture machine varies from 1.4% to 1.57% with a different operating conditions. The power required to operate media mixture machine was in range of 0.62 to 1.06 kW with different operating conditions.

**Keywords:** media, degree of metering, metering mechanism, degree of mixing, Pulverizer

### Introduction
In India, the total area under horticultural crop is 24.9 million hectares with production of 295.2 MT. India is the second largest producer of fruits and vegetables in the world and is the leader in several horticultural crops, namely mango, banana, cashew-nuts, arecanut, pomegranate, sapota, guava. etc. (Anonymous, 2017) [2]. Konkan is the leading region in producing a large variety of fruits comparing to other regions in Maharashtra. In Konkan, area under horticulture crop is 317955 ha with annual production of 755800 Metric ton (Anonymous, 2018) [3]. There are nearly two hundred fifty horticulture nurseries present in Konkan region. Annually for preparing 1,00,000 grafts nurseryman need 200 tonnes of soil (Anonymous, 2015) [1]. Nursery is consequently the basic need of horticulture. Many operations are involved in seedling production which include selection of horticultural crop followed by preparation of media mixture for the selected crop. 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) [10]. Traditionally media is mixed and filled in poly bags by manually. The media are being mixed by spade preferably by men labourers. Then women workers are filling the media mixture in poly bags in sitting posture. In the existing method of media preparation in the horticultural nurseries, both men and women labourers are essentially required for mixing and filling the media. It is not only a tedious job with poor output, but also a laborious work. The manually mixed potting does not get mixed properly and may affect the growth of seedling. It also costs more for completing the task in time. In manual method, only 300-350 bags of 500 g can be filled in a day which costs ₹ 1140 per 1000 bags (Kasten, *et al*, 2011, Essegbemon *et al*. 2014) [8, 4]. The present operation, which is carried out manually using spade for mixing, pulverizing is usually done in unscientific manner and there is no control to avoid contamination in manual handling. Moreover, it is tedious in the bending posture during the operation with spade.

The media siever are commercially available, but complete system for pulverizing, sieving, mixing and metering desired quantity of media are not available at present. All the facilities should be available in one machine. There is need to be mechanised and improved preparation and filling of media mixture for nursery raising. The horticultural plants seedling need media of 500 to 2000 g depending upon crop / variety. The most of the nursery growers are small and medium, growing one lakh to two lakhs grafts / sapling annually. Hence to overcome the above said problems and provide solutions, development of media mixture machine suitable for small and medium size nursery growers of horticultural fruit crops.

## Material and Methods

### Design

Design consideration for design and development of media mixture machine. The power operated media mixture machine was design, developed based on the following assumptions and considerations for design of machine. 1. Particle size requirement Effective size of particle of media mixture should in range 0.5 to 6 mm. (Handreck K.A, 1983) [5]. 2. Capacity of media mixture machine 3. Fine sieving and uniform mixing of media mixture for proper growth of seedling is required. 4. Power requirement of media mixture machine. Volume of mixing chamber calculated by following formula,

$$v = \pi \frac{r2}{2} h$$

Where, v = Volume of mixing chamber, $m^3$, r = Radius of the circular base (0.19 m)
h = Length of the cylinder (0.56 m).

### Torque of mixing drum shaft

According to (Khurmi and Gupta, 2007) [9] shafts may be designed on the basis rigidity and strength.

$$T = F \times l$$

Where, T = Torque, (N.m), l = Length of paddle agitator, m w = F = Force acting on the media, N

$$w = F = mg$$

Where, w = Weight of media, (kg) m = Mass of the media, (kg) and
g = Acceleration due to gravity, ($m/s^2$), $m = F = \text{density} \times \text{volume}$ Power requirement of mixing media in mixing chamber is,

$$P = \frac{2\pi NT}{60}$$

Where, P = Power, W N = Revolution per minute, (Assume mixing drum speed 100 rpm, (Joshi, 1976). T = Torque, Nm (32.7 Nm)
Total power requirement = Power for pulverizing + Power for mixing + Power for sieving

### Design of pulverizing drum

Pulverizing drum consist of lower concave drum, upper drum attached to hopper and beater shaft having eight number of MS flat attached to the main rotating shaft.

### Pulverizing cylinder diameter

$$D_c = \frac{V \times 60}{\pi \times N_c}$$

Where, $D_c$ = Diameter of pulverizing drum, mm V = Peripheral velocity of pulverizing drum, m/s
$N_c$ = Speed of pulverizing drum, rpm
Generally, the length of cylinder taken, 1.5 times of diameter of cylinder. (1.5:1)
Length of pulverizing cylinder (L) = 1.5 × Dc
Where, L = Length of pulverizing cylinder, mm, $D_c$ = Diameter of pulverizing cylinder, mm

### Design of Hopper

The design of feed hopper was derived using following equation: (Patil and Dhande, 2011) [13]. The capacity of hopper was calculated by using following formula.

$$Q = V \times \rho$$

Where, Q = Capacity of hopper, kg V = Volume of the hopper, $m^3$
ρ = Density of soil and FYM, $kg/m^3$.
The volume of hopper was calculated by using following formula,

$$\text{Volume (V)} = A \times L_B$$

Where, V = Volume of the hopper, $m^3$ A = Cross sectional area, $m^2$ $L_B$ = Length of hopper, m
Cross sectional area of hopper was calculated by using following formula

$$\text{Cross sectional area}, A = h\,(B + h \cot \alpha)$$

Where, A = Cross sectional area, $m^2$ h = Height of hopper, m
B = Breadth of hopper, m α = Angle of repose, °

### Beater cylinder shaft

The diameter of the beater cylinder shaft was determined using following design equations: (Sharma and Mukesh, 2010) [15]

$$T = \left(\frac{60P}{2\pi N_{max}}\right) \text{And } T = \left(\frac{\pi}{16}\right) \tau d_s^3$$

Where, P = Maximum power to be transmitted, W $d_s$ = Diameter of MS shaft, mm
T = Torque to be transmitted through shaft, kg-m $N_{max}$ = Maximum rotational speed of shaft, rpm
T = Permissible shear stress of MS = 42 $N/mm^2$

### Length and number of beaters

The number of beaters on the cylinder was calculated by using following formula. (Sharma and Mukesh, 2010) [15],

$$\text{Circumference} = \pi D \text{ No. of beater} = \frac{\pi D}{\text{Distance between beater}}$$

### Concave of pulverizing unit

The length and diameter of concave were 560 and 370 mm, respectively and it is fabricated using 8 mm diameter M.S bars.

**Design of sieve**

The sieve is used for separating large size stone in the media. It is fitted on the sides of main frame i.e upper part and the lower concave of pulverizing drum. The sieve had circular openings.

**Sieve shaker eccentricity and speed**

Ismail (1986) [6] recommended that optimum stroke length of small sieve, $l_s$ as 30 mm. Hence, sieve shaker eccentricity is calculated by using $e_s = \frac{l_s}{2}$ = 30/2

Where, $l_s$ = Stroke length, mm $e_s$ = Eccentricity of sieve, mm

James F. and Sullivan, (2013) [7], had recommended the optimum frequency of stroke, ($n_s$) as 475 strokes / min for sieving. Hence, speed of sieving unit shaft is calculated using $N_e = \frac{n_s}{2}$

Where, $n_s$ = Frequency of stroke/min $N_e$ = Speed of sieving unit, rpm

**Design of sieve shaft**

The design of sieve shaft based on consideration of subjected to combined effect of torsion loading and bending. Hence, according to the maximum shear stress theory (Khurmi and Gupta 2007) [9], the equivalent twisting moment of the shaft is given by,

$$T_{et} = T_{et} = \sqrt{(K_m \times M_{bt})^2 + (K_t \times T_t)^2} \text{ Also } T_{et} = \frac{\pi \times {d_t}^3 \times \tau_t}{16}$$

Where, $T_{et}$ = equivalent twisting moment, N-m $M_{bt}$ = bending moment, N-m

$T_t$ = torque to be transmitted, N-m $\tau_t$ = maximum shear stress of the shaft material, N/m$^2$

$K_m$ = combined shock and impact factors for bending moment

$d_t$ = diameter of main shaft, m.

$K_t$ = combined shock and impact factors for twisting moment,

The torque to be transmitted for shaft to operate shaking mechanism is given as follows,

$$T_t = \frac{P_t \times 60000}{2 \times \pi \times N_t}$$

Where, $P_t$ = available power, kW $N_t$ = shaft speed, rpm; and

$T_t$ = torque to be transmitted, N-m

Let the pulley of diameter 280 mm be mounted on the sieving shaft at a distance of 100 mm from the center of bearing, the tangential load working on the pulley will be,

$$F_{tt} = \frac{2 \times T_t}{D_t}$$

Where, $F_{tt}$ = tangential load, N and $D_t$ = Diameter of pulley, m. and bending moment,

$$M_{bt} = F_{tt} \times x_t$$

Where, $x_t$= Bending moment constant,

**Design of mixing drum**

The diameter and the length of mixing drum are 380 mm and 560 mm, respectively. (Mandhar *et al.*, 2004) [11, 12].

**Design of mixing drum shaft**

The diameter of the mixing drum shaft was determined using following design equations: (Sharma and Mukesh, 2010) [15]

$$T = \left(\frac{\pi}{16}\right) \tau d_s^3$$

Where, P = Maximum power to be transmitted, W $d_s$ = Diameter of MS shaft, mm

T = Torque to be transmitted through shaft, kg-m, $N_{max}$ = Maximum rotational speed of shaft, rpm

T = Permissible shear stress of MS = 42 N/mm$^2$

**Design of pulverizing shaft, mixing shaft and sieving shaft**

The beater shaft, sieving shaft and mixing unit shaft also subjected to torsion loading and bending moment.

**Development of metering mechanism**

Media mixture is required for nursery operations.

**Basic principle of metering mechanism**

The metering mechanism is a device to measure the required quantity media by weight basis.

**Weighing container**

The soil sample is placed in a container. The container is made up of GI sheet 18 SWG. The container is closed at the bottom end and opens at the top end and its diameter is 200 mm and height was 40 mm. Tray size is 200 × 200 mm size was fixed at the bottom on a mild steel plate.

**Collecting container**

The outlet soil sample is collected in the collecting container. The collecting container is made up of GI sheet 18 SWG. The container was closed at the bottom end and opened at the top end. Its diameter was 200 mm and height was 100 mm. It was not fixed at the bottom end because the collecting container has to remove from the position to fill the bags.

**Balancing bar**

Balancing bar is hinged on fulcrum point which is perpendicular to the frame at the bottom. The balancing bar is made from MS flat 25 × 5 mm × 600 mm long hinged with bearing at centre.

**Principle of operation of media mixture machine with metering mechanism**

Collect the soil free from the big clods. The soil was fed continuously, into the pulverizing cylinder. The pulverizing cylinder consist of beaters rigidly fixed on the shaft. The fixed beaters were used to break the soil clod into smaller particles. The smaller particle size of soil passed through concave fall onto the sieve. The opening of the sieve was 5 mm. The soil particle above 5 mm was retained on the sieve. The smaller particles which were passed through the sieve was fall on the retention pan and then it goes to the mixing drum. In mixing drum, all ingredients are mixed properly for the homogenous mixture. The homogenous mixture is required for the proper growth seedling / plant. The mixture came out of the outlet.


**Fig 1:** Developed media mixture machine for horticultural crop nursery.

**Table 1:** Specification of developed media mixture machine for horticultural crop nursery.

| Sr. No | Parameter | Specification |
|---|---|---|
| A) Pulverizing drum | | |
| 1 | Diameters, mm | 370 |
| 2 | Length, mm | 560 |
| 3 | Thickness of (M.S flat sheet), mm | 3 |
| 4 | Concave clearance, mm | 8 |
| 5 | No. of beater | 8 |
| | Length of beater, mm | 120 |
| | Width of beater, mm | 40 |
| | Thickness of beater, mm | 8 |
| B) Shaking sieve | | |
| 1 | Length, mm | 580 |
| 2 | Width, mm | 460 |
| 3 | Height, mm | 50 |
| C) Mixing drum | | |
| 1 | Length of drum, mm | 560 |
| 2 | Diameter of drum, mm | 380 |
| 3 | Paddle type agitator | |
| | No. of paddle, | 8 |
| | Height of paddle | 150 |
| | Length of paddle, mm | 100 |
| | Width of paddle, mm | 70 |
| D) Diameter of shafts | | |
| 1 | Pulverizing shaft, mm | 25 |
| 2 | Mixing shaft , mm | 25 |
| 3 | Sieving shaft, mm | 20 |
| E) Main frame | | |
| 1 | Height, mm | 970 |
| 2 | Length, mm | 920 |
| 3 | Width, mm | 580 |
| F) Overall dimensions of machine | | |
| 1 | Height, mm | 970 |
| 2 | Length, mm | 920 |
| 3 | Width, mm | 760 |

## Results and Discussions

Based on result of developed media mixture machine for horticultural crop nursery, conclusions were drawn on the basis of research work. The media obtained from machine was uniform and properly mixed which was required for better establishment of nursery sapling. It was found that bulk density of media mixture decreases whereas particle density and total porosity increases of media mixture after passing through pulverizing and mixing drum of developed machine. The size of media obtained as minimum 1.97 mm at 140 kg/h feed rate. The thoroughly mixed media mixture was obtained from developed media mixture machine. The degree of metering of developed media mixture machine varies from 1.4% to 1.57% with a different operating conditions. The power required to operate media mixture machine was in range of 0.62 to 1.06 kW with different operating conditions.

## References


1. Anonymous. Report submitted by Joint Director of Agriculture, Konkan division, Dept. of Agril. Thane during Kharif Review Meeting 2015.
2. Anonymous. Horticulture Statistics at a Glance. Government of India. Department of Agriculture, Co-operation and farmers Welfare, Horticultural Statistics Division 2017, 9-12.
3. Anonymous. Ministry of Agriculture and Farmer Welfare, Govt. of India. District level agristat statistical information of India 2018. Retrieved 16 August 2019, from https://www.Districtofindia.com_
4. Essegbemon A, Stomph TJ, Paul DK, Struik C. Growth dynamics of tree nursery seedlings: The case of oil palm. Scientia Horticultural. 2014;175(15):251-257.
5. Handreck KA. Particle Size and the Physical Properties of Growing Media for Containers. Commun. in Soil sci.

plant anal. 1983;14(3):209-222.
6. Ismail FH. Engineering and technological study on cleaning and grading crops. M.Sc. Thesis, Faculty of Agricultural Mansoura University, Maunsoura, Egypt 1986.
7. James F, Sullivan PE. Screening theory and practice. Triple/S Dynamics, Inc. 2013, 1-3.
8. Kasten D, Heiskanen J, Englund K, Tervahauta A. Pelleted biochar: Chemical and physical properties show potential use as a substrate in container nurseries. Biomass and Bioenergy 2011;35(5):2018-2027.
9. Khurmi RS, Gupta JK. A Textbook of machine Design. 14 Edition. Eurasian Ltd. Ram Nagar. New Delhi 2007, 313-351.
10. Krishnan P, Roy MM, Tewari JC. Plant Nursery Management, Principle and Practices. Published by Central Arid Zone Institute, Jodhpur 2014, 6-7.
11. Mandhar SC, Rathinakumari AC, Kumaran GS. Development of machinery and greenhouses for vegetable nursery raising. International seminar on downsizing technology for rural development. Indian Institute of Horticultural Research, Bangalore 2004a, 57-59.
12. Mandhar SC, Rathinakumari AC, Kumaran GS. Development of machinery and greenhouses for vegetable nursery raising. Indian Institute of Horticultural Research, Bangalore 2004b, 57-59.
13. Patil A, Dhande KG. Development and Performance Evaluation of Bullock Drown dry paddy seed cum fertilizer drill unpublished M. Tech (Agril Engg.) FMP Thesis, College of Agricultural Engineering and Technology Dapoli, Dr. Balasaheb Sawant Konkan krishi Vidyapeeth Dapoli 2011.
14. Rynk R. On-farm Composting Hand book, North east Regional Agricultural Engineering Service, NRAES-1992;54:9-10.
15. Sharma DN, Mukesh S. Farm machinery design, Principle and Problems, 2nd Edition 2010.