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Stone Characterization, Media Analysis and its Influence on Polyembryonic Rootstocks Germination of Mango (*Mangifera indica* L.)

G. Nayan Deepak[1]*, U. Jeevan[2], Chandu Singh[3], H.L. Priyanka[4] and S. Jaganath[4]

[1]Division of Fruits and Horticultural Technology, ICAR- Indian Agricultural Research Institute, New Delhi-110012, India
[2]College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur, Kerala-680656, India
[3]Seed Production Unit, ICAR- Indian Agricultural Research Institute, New Delhi-110012, India
[4]Division of Fruit crops, College of Horticulture, Bengaluru, UHS Campus, Karnataka-560065, India

**Corresponding author*

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A B S T R A C T

The present investigations was carried out for stone characterization, analyze the physico-chemical properties of media and to identify the best suitable media for germination using different polyembryonic rootstocks of mango during 2012-13 at Regional Horticultural Research and Extension Centre, Bengaluru. The studies revealed that, the significant variation was found in stone attributes (weight, length, breadth, circumference and volume). Based on germination test, the Olour rootstock showed better germination (earliest germination 21.33 days, minimum days for 50 per cent germination 31.78 days, higher germination percentage 43.78% and rate of germination 0.016) in compared to other rootstocks. Further, out of three media, the Cocopeat media showed better physical and chemical properties (pH 7.55, water holding capacity 216.04% and pore space 64.01%) and it was also observed that, cocopeat has been taken less time for germination initiation (20.78 days), 50 per cent of germination (33.67 days), maximum germination (48%) and rate of germination (0.016) compared to other media. Furthermore, the interaction effect between media and rootstock showed significant difference on germination behavior. Therefore, the Olour stones showed significant germination on Cocopeat media; hence the generated information could be utilized by nurseryman for getting maximum germination of rootstocks in a nursery.

Introduction

Mango (*Mangifera indica* L.) was originated in South East Asia and which belongs to Anacardiaceae family (De Candolle, 1904 and Mukherjee, 1951). The Mango is a tropical as well as subtropical crops and it required elevation of about 1400 meters above mean sea level. Among the Mango producing countries in the world, India stands on top for

production. This crops occupied an area of 25.16 lakh ha and annual production is 184.31 lakh tons (Anon., 2014). Out of 29 states of countries, the Uttar Pradesh is occupied largest area under mango cultivation followed by Andhra Pradesh, Karnataka, Telangana and Bihar. There is an enormous scope for increasing the area and productivity of mango in the country.

Mango seed is known as stone, which are solitary, large and flat, ovoid oblong and surrounded by the fibrous endocarp at maturity. The mango stone constitute up to 20% of fruit weight. The testa and tegumen are thin and papery respectively and embryos are dicotyledonous in nature (Richard, 2009). Bally 2006, reported that, the mango crop possesses a distinct characteristics known as polyembryonic (apomictic) or monoembryonic seed. A polyembryonic seeds encompasses more than two or more embryos and they are produced from zygotic (sexual) and nucellar (asexual or maternal) embryos whereas, in case of monoembryonic seeds comprise only a single zygotic embryo (zygotic seedlings). The zygotic seedlings as well as nucellar seedlings are used as rootstocks (Bally, 2006). The Nucellar seedlings are identical to its parent plant (Xiang and Roose, 1988; Garcia *et al.,* 1999; Ruiz *et al.,* 2000). Rao *et al.,* 2008, reported that nucellar seedlings are a true to type and which maintain the genetic homogeneity of rootstocks. Frost and Soost, 1968, reported that, the nucellar seedlings showed differences due to somatic variations.

The various types of growth media are available for use in propagation, but those media encompasses *i.e.* fine sand mixed with varying proportions of soil, coco peat, peat moss, saw dust, rice hull, FYM etc, are added. Media is a very complex system, which is made up of solid, liquid and gaseous materials. The germination of seed is not only affected by media properties, but also influence vagaries environmental factors (Hartmann *et al.,* 2001). In most of the nurseries, 1:1:1 ratio of red earth, sand and FYM are used for germination and growth of seedlings. The Cocopeat is an agricultural by-product obtained after the extraction of fiber from the coconut husk (Abad *et al.,* 2002) and which has better physical and chemical properties such as high water holding capacity, high pore space, low shrinkage, low bulk density and slow degradation (Prasad 1997). The germination of mango stones mainly depends on the chemical as well as physical properties of media *viz.,* optimum water holding capacity, electrical conductivity, pH and aeration. Even though, the vegetative propagation is a commercial method in mango but, rootstock rising is also important. The polyembryonic varieties of mango gives genetic homogeneity or true to type plants from seeds thus, could be used as rootstock. Therefore, in view of above background, the present investigations was framed with an objective of analyzing the physical and chemical properties of media, stone characterization and ascertain the suitable media for germination of polyembryonic mango stones for rootstocks.

Materials and Methods

This studies followed by two experimental designs *i.e.* completely randomized block for recording data of stone attributes whereas, factorial randomized complete block design was used for recording data on germination parameters (Panse and Sukhatme, 1967) and both the design were carried out during 2012-13 at Regional Horticultural Research and Extension Centre, University of Horticultural Sciences, Bagalkot, GKVK (West), Bengaluru, Karnataka. The field is located at an altitude of 930 meters above mean sea level, 12° 58’ North latitude and 77° 35’ East longitude. The soil of experimental site

comprised of red sandy loam with pH of 7.75 and EC of 0.14 ds/m. The average annual rainfall is 923.7 mm and temperature ranges from 15^0C to 35.2^0C.

In this investigation, three growth media has been selected such as, Cocopeat (T_1), red earth + sand +vermicompost (T_2) with a ratio of 1:1:1 and red earth + sand + FYM (T_3) with a ratio of 1:1:1 (control) were used for media analysis and these media was used germination studies using three different polyembryonic rootstocks *viz.,* Olour (V_1), Vellaikolumban (V_2) and Nekkare (V_3) which were procured from Indian Institute of Horticultural Research, Hessaraghatta. Analysis of media was carried out as per described by Srinivasamurthy *et al.,* 2010. The pH and EC was determined using professional bench top pH meter and electrical conductivity meter respectively. The maximum water holding capacity (%) was estimated by [(weight of saturated sample-weight of oven dry sample)/ weight of oven dry sample x 100]. The bulk density was determined by core method and calculated as Weight of oven dry core soil/ volume of the sample (g/cc).

Similarly, particle density was calculated by the formula, weight of oven dry soil / volume of the solids excluding pore space (g/cc). The pore space was calculated [1-{BD/PD}] x 100, where BD- bulk density, PD- particle density. The porosity was calculated from bulk density and particle density *i.e.* bulk density/ particle density. Stone characters like weight, length, breadth, circumference and volume were observed from ten replications (five stones per replication). A total of three replications with a fifty stones per replication were used for germination studies. The germination parameters *viz*., initiation of germination, 50 per cent of final germination, germination percentage and rate of germination were recorded as per described by Bewley and Black (1982).

Results and Discussion

The germination behavior of seeds mainly depends on the physical and chemical properties of media. The physical and chemical properties of media are shown in Table 1. Out of three media, T_1 media showed the higher pH value (7.55) and pore space (64.01%) followed by T_3 and T_1 media.

Though there was a variation among pH, but the values are within the neutral range (6.5-8.5). The pH value was comparatively less in T_2 and T_3, this may be due to the presence of organic acids in vermicompost and FYM respectively. The minimum EC value was noticed in T_2 (1.0 ds/m), while it was comparatively more in T_1 (1.3 ds/m) and T_3 (1.4 ds/m). EC values of media falls in medium salinity (0.8-1.6 ds/m). Minimum value for bulk density (0.30 g/cc), particle density (0.86 g/cc) and total porosity (0.35 %) was recorded in T_1, while as maximum was recorded in T_2 and T_3. The maximum water holding capacity (216.04%) and pore space (64.01%) was noticed in T_1, compared to T_2 and T_3.

Among media, the Cocopeat had better physical and chemical properties required for germination. Similar finding was reported by Farzad *et al.,* (2011) and Shanmugasundaram *et al.,* (2014).

Significant difference was observed for stone attributes (Fig. 1 and 2). The maximum stone weight (20.53 gm), breadth (5.31 cm) and circumference (11.47 cm) was observed in stones of rootstock Olour, while as the maximum length (8.64 cm) and volume (41.69 ml) was recorded in stones of rootstock Vellaikolumban. There was a wide variation for stone characters in polyembryonic genotypes than the monoembryonic genotypes (Abirami *et al.,* 2011). These results are in accordance with Divekar and Bisen (2016).

Table.1 Chemical and Physical properties of media

Media	Chemical properties				Physical properties		
	pH	EC (ds/m)	Bulk, density (g/cc	Particle density (g/cc)	Total porosity	Water holding capacity (%)	Pore space (%)
T_1	7.55	1.3	0.30	0.86	0.35	216.04	64.01
T_2	6.92	1.0	1.19	1.88	0.63	30.66	33.94
T_3	7.11	1.4	1.16	1.77	0.66	29.21	34.18

* T_1 - Cocopeat, T_2 - 1: 1: 1 of red earth + sand + vermicompost and T_3 - 1:1:1 of red earth + sand + FYM

Table.2 Stone characters of different polyembryonic rootstocks

Rootstocks	Stone weight (gm)	Stone length (cm)	Stone breadth (cm)	Stone circumference (cm)	Stone volume (ml)
V_1	20.53	8.19	5.31	11.47	35.58
V_2	15.47	8.64	4.85	8.15	41.69
V_3	19.30	6.87	4.47	9.77	39.20
CD @ 5%	**0.456**	**0.18**	**0.147**	**0.158**	**0.224**

*V_1 - Olour, V_2 - Vellaikolumban and V_3 - Nekkare

Table.3 Influence of different media on days taken for initiation, 50 per cent germination, germination percentage and rate of germination of different mango rootstocks

Media	Initiation of germination (days)	50 per cent of germination (days)	Germination (%)	Rate of germination
T_1	20.78	33.67	48.00	0.016
T_2	25.11	36.00	38.44	0.015
T_3	29.00	39.44	35.56	0.014
CD at 5%	**1.803**	**1.498**	**3.092**	**0.0005**
Rootstocks				
V_1	21.33	31.78	43.78	0.016
V_2	29.11	40.44	36.89	0.014
V_3	24.44	36.89	41.33	0.015
CD at 5%	**1.803**	**1.498**	**3.092**	**0.0005**

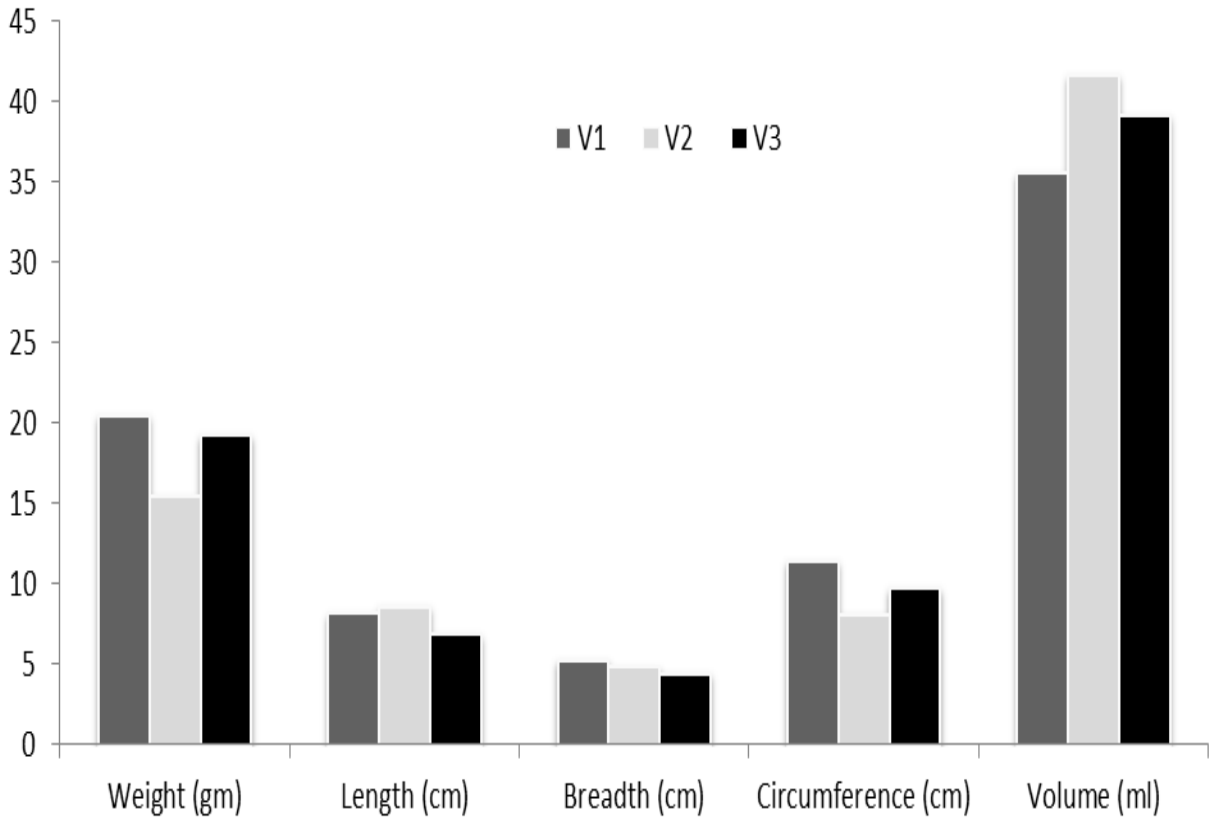
* T_1 - Cocopeat, T_2 - 1: 1: 1 of red earth + sand + vermicompost and T_3 - 1:1:1 of red earth + sand + FYM. V_1 - Olour, V_2- Vellaikolumbanand V_3 - Nekkare

Table.4 Interaction effect of different media and mango rootstocks on days taken for initiation, 50 per cent germination, germination percentage and rate of germination

	Initiation of germination (days)			50 per cent of germination (days)			Germination (%)			Rate of germination		
	Rootstocks											
Media	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
T_1	17.67	25.33	19.33	29.67	36.67	34.67	54.00	40.00	50.00	0.017	0.015	0.016
T_2	20.67	29.67	25.00	31.00	40.33	36.67	40.00	36.67	38.67	0.016	0.014	0.015
T_3	25.67	32.33	29.00	34.67	44.33	39.33	37.33	34.00	35.33	0.015	0.014	0.013
CD at 5%		**3.113**			**2.587**			**5.363**			**0.0008**	

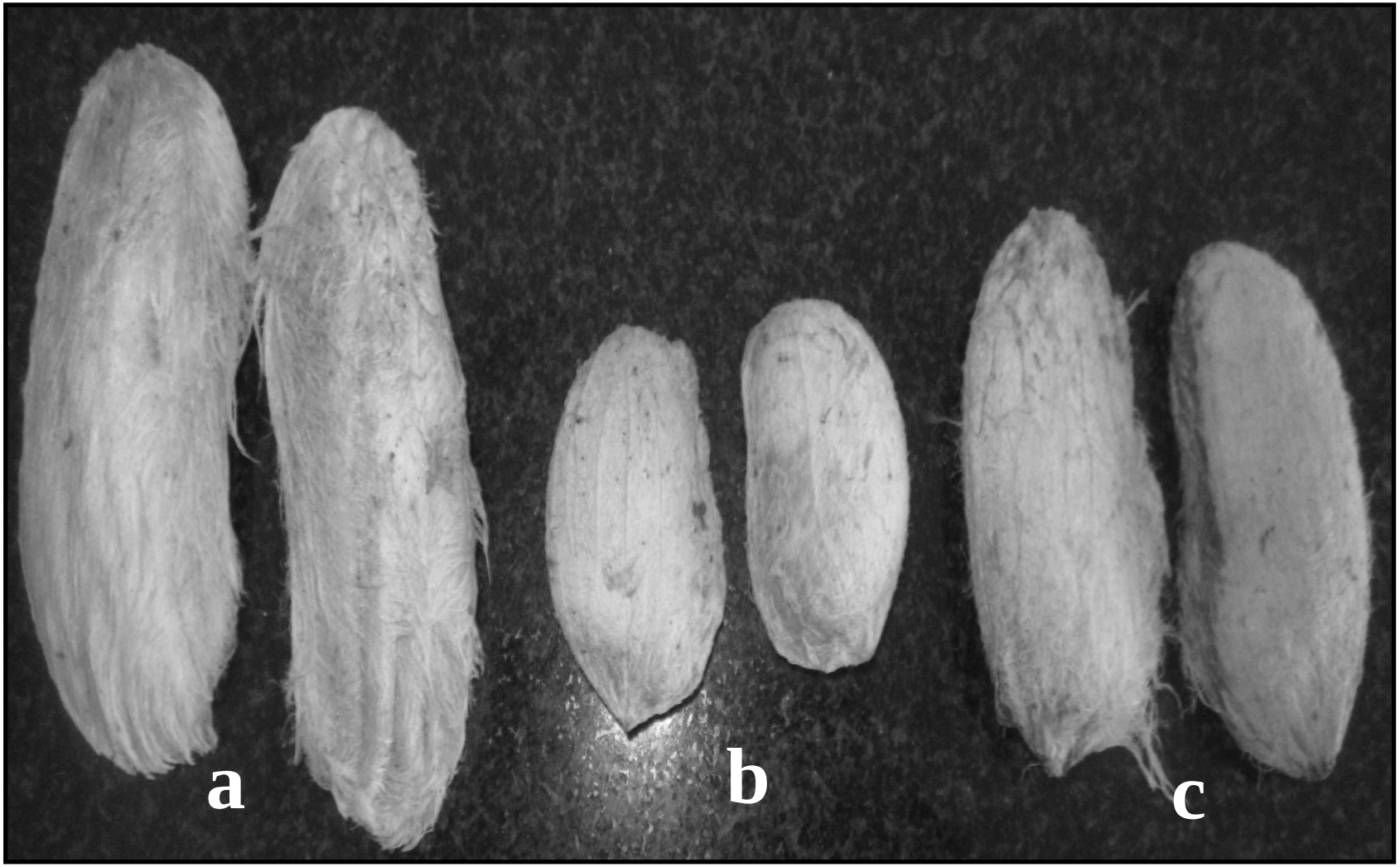
* T_1 - Cocopeat, T_2 - 1: 1: 1 of red earth + sand + vermicompost and T_3 - 1:1:1 of red earth + sand + FYM. V_1 - Olour, V_2 - Vellaikolumbanand V_3 - Nekkare

Fig.1 Stone attributes of Polyembryonic Mango rootstocks



V_1 - Olour, V_2 - Nekkare, V_3 Nekkare

Fig.2 Stones morphological variation of polyembryonic mango rootstocks



a. Vellaikolumban, b. Nekkare and c. Olour

The stone germination characters of polyembryonic mango rootstocks in media are presented in Table 2. The studies revealed that, there was a significant difference for germination parameters *viz.*, days taken for initiation of stone germination, days taken to reach 50 per cent of final germination, germination percentage and rate of germination in polyembryonic mango rootstocks was observed. The minimum days taken for initiation (21.33 days) and 50 per cent of germination (31.78 days), maximum germination per cent (43.78) and rate of germination (0.016) was observed in stones of rootstock Olour, whereas, in case of Vellaikolumban took - longer period for initiation (29.11 days) and for 50 per cent of germination (40.44 days) and also observed minimum germination percentage (36.89) and rate of germination (0.014). Out of three media, the coco peat alone took less time for initiation (20.78 days) and 50 per cent of germination (33.67 days) for initiation, high germination per cent (48.00) and speed of germination also high (0.016). However, long period for initiation (29.00 days) and for 50 per cent of germination (39.44 days), minimum germination per cent (35.56) and rate of germination (0.014) was observed in media red earth+ sand+ FYM (1:1:1).

Furthermore, the interaction effect of media with rootstock for earliest germination was recorded in T_1V_2 (17.67 days), which was *on par*withT_1V_3 (19.33 days) and T_2V_1 (20.67 days). The minimum days taken for 50 per cent germination was noticed in T_1V_1 (29.67 days), which was *on par* with T_2V_1 (31.00 days).

The maximum germination percentage was observedinT_1V_1 (54.00) and was *on par* T_1V_3 (50.00). The maximum rate of germination was noticed in T_1V_1 (0.017). The maximum days taken for initiation (32.33) and 50 per cent germination (44.33) and minimum germination percentage (34.00) was recorded in T_3V_2. Whereas, T_3V_3 (0.013) was recorded the lowest rate of germination (Table 3).

Early germination in rootstock Olour may be due to higher weight of stone, hence the endosperm weight could also be more. The heavier seeds gave better germination, produced healthy seedlings with greater vigour and more number of quality seedlings (Ahirwar, 2012 and Omokura *et al.,* 2015). The germination may be affected by seed moisture content (Grisez, 1974). The heavy weight seed have positive relationship with germination characters (Olorunmaiye *et al.*, 2012, Muralidhara *et al.,* 2016, Prajapati *et al.*, 2012 in mango and Derya *et al.,* 2007 in *Prunus serotina*). The media coco peat alone enhances early germination, which may be attributing to its better physico-chemical properties. The coco peat having low bulk density and particle density, maximum water holding capacity, pore space and good chemical properties may have been influenced germination (Table 5).

The high water holding capacity could have increased the absorption of water thereby trigger α- amylase activity, which in turn helps in early emergence of plumule. The present findings were in agreement with Snyman (1981); Geetha *et al.,* (2007) in mango, Bhardwaj *et al.,* (2014) in papaya and Neha Chopde *et al.,* (1999) in custard apple. Whereas, in case of media red earth, sand and FYM (1:1:1) showed lower stone germination might be due to higher bulk density, higher particle density, lower water holding capacity and pore space.

Cocopeat had better chemical and physical properties, hence better stone germination behaviour of rootstock colour was observed. This information could be helpful (nurseryman) for maximum germination of seeds in nursery.

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