Influence of potting mixture and sowing orientation on physiological parameters of *Balanitesroxburghii* (Linn.)

Abstract:

Balanites roxburghii (Linn.) species has been classified under the category of endangered plant species due to excessive exploitation for a variety of purposes, which has necessitated conservation of this tree species, and hence a study was conducted to investigate the effect of potting mixture and sowing orientation on early growth performance and vigour. Seeds were subjected to seven potting mixtures: M1: Soil:Sand:FYM 2:1:1, M2: Soil:Cocopeat:FYM 2:1:1,M3: Soil:Cocopeat:Vermicompost 2:1:1, M4: Soil:PaddyHusk:FYM: 2:1:1, M5: Soil:PaddyHusk:Vermicompost: 2:1:1, M6: Soil: Saw Dust:FYM 2:1:1, and M7: Soil:sawdust: Vermicompost 2:1:1. The seeds were sown in three orientations. S1: Seeds laid vertically with stalk end downwards; S2: Seeds laid horizontally and S3: Seeds laid vertically with stalk end upwards. Physiological parameters considered for assessment were seed germination, days taken for germination, seedling length, and seedling vigor index. A completely randomized design was used for the experiment. The results showed that there is a significant difference among seven different potting mixtures and three orientations. At the end of 8 weeks, the seed is sown horizontally in the potting mixture Soil:cocopeat:vermicompost (2:1:1) has recorded the germination percentage of 71.67%, 37 days taken for seed germination, highest seedling length (64 cm), and highest seedling vigour index (4561). The high-vigor seedlings may survive even in unfavorable conditions, with high survival rate compared to others. The study recommended that to obtain high-vigor *Balanites roxburghii* seedlings, seeds may be sown in potting mixture soil: cocopeat: vermicompost (2:1:1) with horizontal orientation.

Key words: Potting mixture, Orientation, Seedling vigourIndex, Seed germination

Introduction

*Balanites roxburghii*Linn.is commonly called as ‘Desert Date’ in English belongs to family of Zygophyllaceae. It is one of the most neglected and underutilized plant species found in dry areas of Africa and South Asia (Daya et al., 2011). In India, it is naturally found in Rajasthan, Gujarat, Madhya Pradesh and Deccan Plateau (Aditya et al., 2023).This plant grows in harsh climate (arid and semi-arid) and vide variety of soil ranging from sandy loamy soil to deep black soil. The plant grows as a thorny shrub to small tree and is being locally used for multiple utility.Especially for its

medicinal value. The fruits, pulp, seed, leaves, bark and roots have antimicrobial, anticancer, antiviral, antidiabetic, antioxidant, anti-inflammatory and other properties used locally to cure many of the diseases such as jaundice, intestinal worm infection, wounds, malaria, syphilis, epilepsy, dysentery, constipation, diarrhea, hemorrhoid, stomach aches, asthma, and fever. (Al-Thobaiti and Zeid, 2018; Saboo et al. 2014; Hammiche and Maiza, 2006). That apart leaves and fruits are used as a fodder for livestock (Orwa et al., 2009). The diosgenin content in roots and fruits are used to make oral contraceptive, sex hormone and steroids (Chapagain et. al., 2009). Young shoots and leaves are used vegetables by the tribes and In Africa ripen fruits are eaten raw or after sun dried. Further, in India pulp of the fruit is used as detergent to wash the cloths and wood is used to make agricultural implements and as a fuel wood and it is also being assisted on the boundary of agriculture land as live fence since as it is a thorny species with small crown and height.

This species is one of the natural compositions of dry evergreen or thorn forest of semi-arid climate. However, in recent past the population of this species is dwindling due to various factors such as poor germination, biotic pressure, forest fire and reduced ethnobotanical usage.

The species is mainly regenerated through seeds; however, the seeds of this species are of varying in size, weight and germination percentage. As fruits are of brittle and smooth mesocarp and consists of oil and fibers endocarp. Hence, freshly sown seeds have higher germination compared to too late sowing and it studies indicated the species do not require seed treatment. However, treating seeds with cold and hot water reported enhanced regeneration whereas, minimal work is done on the potting mixture which is most important for raising seedlings in nursery for afforestation and plant conservation and similarly on the orientation of sowing seeds.Keeping this in view the present investigation was undertaken to know the influence of potting mixture and orientation of sowing seed on physiological traits.

Material and methods

The present investigation on influence of potting mixture and orientation of seeds on physiological traits of *Balanites roxburghii* were carried out in and around Raichur district of Karnataka, India, which falls under North Eastern Dry Zone (Zone-II) of Karnataka Agroclimatic Zones and study site is located between 16°.15 N latitude and 77°.20 E longitude and at 398.37 m above mean sea level.Average monthly temperature of this area normally around 25°C (January) to 35°C (July) with a mean annual rainfall of 680 mm and climate of the study area is of semi-arid with mild temperature in the winter and high harsh temperature in summer. The soils are mainly medium to deep black soils in major part and also red loamy and sandy loamy in few pockets.

The ripen fruits were collected in the month of January from well grown trees from nearby area and on the boundary of agricultural lands and fruits brought to the laboratory and were dried under shades for 15 days later fruits soaked in the cold water for 24 hours and were de-pulped and were sown in the pots. The experiment wascarried out with CRD in pots with two factors of which 7 main factors with different potting mixture and 3 sub factors of seed orientation. Further, 25 de-pulped seeds were sown for each factor and were replicated into four times. The details of the main and sub factors are given below.

Factor I: Potting media

M1: Soil:Sand: FYM 2:1:1

M2: Soil: Coco peat: FYM 2:1: 1

M3: Soil: Coco peat: Vermicompost 2:1:1

M4: Soil: Paddy husk : FYM : 2:1:1

M5: Soil : Paddy husk : Vermicompost : 2:1:1

M6: Soil : Saw dust : FYM 2:1:1

M7: Soil : saw dust : vermicompost 2:1:1

Factor II: Orientation

S1 : Seed laid vertically with stalk end downwards

S2 : Seeds laid horizontally

S3 : Seeds laid vertically with stalk end upwards

The experiment was continuously monitored and regular watering was done to keep the adequate moisture for 8 weeks. The data on germination was observed daily and seeds were considered germinated on emergence of healthy plumule through media and data obtained were subjected to assess germination, seedling length and seedling vigor index using the following equations. Then, data were subjected to statistical analysis using MS-Excel at P level of 0.01.

Seed germination assessment : The data on germination was recorded on weekly basis for a period of eight weeks. The germination percentage was calculated by the following formula :

$$\text{Seed Germination (\%)} = \frac{\text{Germinated seeds}}{\text{Total number of seeds}} \times 100$$

Seedling length (cm)

Ten normal seedlings were selected at random from each treatment. The seedling length was measured from the shoot tip to root tip of the seedling and the mean wasexpressed in

centimeters (cm).

Seedlingvigourindex-I

The seedlingvigourindex-I wascalculatedaspertheformulagivenbyAbdulBaki and Anderson(1973) expressed as whole number.

Seedling vigour index-I =Germination(%)xMeanseedlinglength(cm)

Results and discussion

Seed germination

The investigation of influence of potting mixture and orientation of seeds on physiological traits of Balanites revealed significant difference with potting mixture and seed orientation. Significantly, higher seed germination was noticed in M1potting mixtureSoil : Sand : FYM (2:1:1) (69.00 %), followed by Soil: Coco peat: VermicompostM3 (2:1:1) (59.56%). Whereas significantly lower germination was recorded in M4 Soil: Paddy husk : FYM (2:1:1) (41.89%) (Table.1). This could be attributed that standard ratio followed for nursery raising seedlings as sand helps for better aeration followed by adequate nutrients from soil and FYM helped the germination as the seed of Balanites has more surface area and bigger in size and lower germination in treatments could be due to lack of aeration. Similarly, Akanbi et al., 2002 reported that, for better germination of seeds needs adequate aeration and nutrients

Among the different seed sowing orientations, significantly higher seed germination was observed with seed oriented vertically with stalk end upwards (67.76 %) and seed laid horizontally (61.14 %) respectively. However, significantly, lower seed germination was recorded in seed oriented vertically with stalk end downwards (31.19 %). Since orienting seeds with stalk end upwards and laying seeds horizontally results in less difference in seed germination percentage. It is better to sow the seeds horizontally since this is the normal orientation of seeds/fruits, when fall on the ground. Also, orienting seeds with stalk end with upwardsby inexperienced persons can lead to sowing the seeds in stalk end upwards. Seeds must be placed in a position that allowed the uptake of water and other environmental variables required for germination (Bowers and Hayden 1972). These results are line with the findings of Elffel (2012),El Nour and Kalislo (1995) and Lucky & Usman (2022) in *Balanitiesaegyptiaca*.

The study on interaction between potting mixture and orientation revealed significant difference.Significantly, higher seed germination (84.33) was recorded in Soil:Sand:FYM (2:1:1) with Seeds laid vertically with stalk end upwards followed by the potting mixture Soil : Sand : FYM

(2:1:1) with seeds laid horizontally (81.00%). Whereas, significantly, lower seed germination percentage was recordedinSoil: Paddy husk : FYM (2:1:1) with Seed laid vertically with stalk end downwards (23.33%).This might be due to better aeration in potting mixture with sand and adequate nutrients as well as orientation of the seed. If seeds sown vertically with stalk downwards may die due to lack of good aeration and needs lot of energy to produce the plumules which comes from the stalk. Hence, to get higher germination it is better to sow the seeds vertically keeping stalk at upwards.

Table 1: Effect of planting mixture and seed sowing orientation on seed germination in *balanitesroxburghii*

Germination percentage												
	2022				2023				Pooled			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_1	42.33	80.33	83.67	**68.78**	41.00	81.33	85.00	**69.11**	41.67	81.00	84.33	**69.00**
M_2	35.00	68.00	71.67	**58.22**	32.33	69.00	73.67	**58.33**	33.67	68.67	72.67	**58.33**
M_3	33.67	71.00	74.33	**59.67**	30.33	72.33	74.67	**59.11**	32.33	71.67	74.67	**59.56**
M_4	25.33	47.33	56.00	**42.89**	21.00	46.00	54.33	**40.44**	23.33	47.00	55.33	**41.89**
M_5	27.67	49.67	59.67	**45.67**	26.67	51.33	57.67	**45.22**	27.67	50.67	58.67	**45.67**

M_6	28.67	54.33	62.67	**48.56**	27.00	48.33	63.67	**46.33**	28.00	51.67	63.33	**47.67**
M_7	31.67	57.33	65.33	**51.44**	31.66	57.33	58.33	**49.11**	31.67	57.33	62.33	**50.44**
	32.05	**61.14**	**67.62**		**30.00**	**60.81**	**66.76**		**31.19**	**61.14**	**67.33**	
	S.Em.±	CD @ 1 %			S.Em.±	CD @ 1 %			S.Em. ±	CD @ 1 %		
Factor A	0.452	1.295			0.738	2.114			0.499	1.428		
Factor B	0.296	0.848			0.483	1.384			0.356	0.935		
A XB	0.783	2.244			1.279	3.662			0.864	2.474		

M1: Soil:Sand: FYM 2:1:1
M2: Soil: Coco peat: FYM 2:1:1
M3: Soil: Coco peat: Vermicompost 2:1:1
M4: Soil: Paddy husk : FYM : 2:1:1
M5: Soil : Paddy husk : Vermicompost : 2:1:1
M6: Soil : Saw dust : FYM 2:1:1
M7: Soil : saw dust : vermicompost 2:1:1
S2 : Seeds laid horizontally
S1 : Seed laid vertically with stalk end downwards
S3 : Seeds laid vertically with stalk end upwards

Days to germination

The study on time taken to complete germination noticed significant difference with potting mixture and orientation. Significantly, minimum numbers of days taken to complete germination were observed in soil:Sand:FYM (28.78 days) followed by Soil:Cocopeat:FYM (34.44 days) and Soil:Cocopeat: Vermicompost (37.44 days). However, significantly maximum number of days were taken complete the germination was recorded in the potting mixture Soil:Paddy husk: Vermicompost (45.67days). This may be attributed better aeration and adequate nutrients in potting mixture with sand as compared to without sand.

Similarly, significant difference in time taken to complete germination was noticed with sowing orientation. Significantly, minimum number of days taken to complete germination were recorded in seeds sown vertically with stalk upward germinate (31.33 days) followed by horizontal sowing. However, significantly, maximum number of days taken to complete germination was recorded in seeds sown vertically with stalk downward (46.71days). This could be due to keeping stalk downward needs lot of energy to produce plumule and lack of aeration. The results are in conformity with Kelvin et al (2015) who reported a significant difference in germination speed of *Lagenaria siceraria* sown in a different orientation.

The interaction between potting mixture and sowing orientation was also noticed significant difference in time take to complete germination. Significantly, minimum number of days taken to complete germination were recorded in potting mixture Soil:Sand:FYM with seeds sown vertically with stalk upward (18.00 days). However, significantly maximum number of days taken to complete the germination were recorded in potting mixtureSoil: Paddy husk : FYM (2:1:1) with seeds sown

vertically with stalk downwards (49.33 days). Similar results were also reported by Lucky and Usman (2022).

Table 2: Effect of planting mixture and seed sowing orientation on days taken for germination in *balanitesroxburghii*

Days taken for germination												
	2022				2023				Pooled			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_1	44.00	25.67	18.33	**29.33**	43.33	22.33	17.67	**27.78**	44.00	24.33	18.00	28.78
M_2	47.67	33.67	22.33	**34.56**	48.00	31.67	22.00	**33.89**	48.00	33.00	22.33	34.44
M_3	45.33	38.33	27.67	**37.11**	47.00	35.33	29.67	**37.33**	46.67	37.00	28.67	37.44
M_4	49.67	43.33	39.00	**44.00**	48.33	41.67	39.00	**43.00**	49.33	42.67	39.33	43.78
M_5	47.00	47.33	40.67	**45.00**	47.67	49.33	40.33	**45.78**	47.67	48.67	40.67	45.67
M_6	45.33	41.67	39.33	**42.11**	48.33	43.67	37.00	**43.00**	47.00	43.00	38.33	42.78
M_7	42.67	35.67	32.00	**36.78**	45.67	36.00	32.00	**37.89**	44.33	36.00	32.00	37.44
	45.95	**37.95**	**31.33**		**46.91**	**37.14**	**31.10**		**46.71**	**37.81**	**31.33**	
	S.Em.±	**CD @ 1 %**			**S.Em.±**	**CD @ 1 %**			**S.Em.±**	**CD @ 1 %**		
Factor A	0.396	1.135			0.806	2.307			0.544	1.559		
Factor B	0.259	0.743			0.527	1.511			0.356	1.021		
A XB	0.686	1.965			1.395	3.996			0.943	2.700		
M1: Soil:Sand: FYM 2:1:1 M3: Soil: Coco peat: Vermicompost 2:1:1 M5: Soil : Paddy husk : Vermicompost : 2:1:1 M7: Soil : saw dust : vermicompost 2:1:1 S1 : Seed laid vertically with stalk end downwards					M2: Soil: Coco peat: FYM 2:1:1 M4: Soil: Paddy husk : FYM : 2:1:1 M6: Soil : Saw dust : FYM 2:1:1 S2 : Seeds laid horizontally S3 : Seeds laid vertically with stalk end upwards							

Seedling Length

The study on seedling growth was also significantly differed with potting mixture and seed orientation. Significant differences were observed among the different treatments with regard to seedling length was observed in seed sown horizontally in potting mixture Soil: Cocopeat: Vermicompost (2:1:1) and results presented in table 3.

The highest seedling length (64.00 cm) was recorded in seed sown horizontally in potting mixture Soil: Cocopeat: Vermicompost (2:1:1),where as the lowest seedling length (20.67 cm) was recorded in potting mixture Soil:Sand:FYM (2:1:1) with seed sown vertically stalk end downwards. Vermicompost provides adequate nutrients and enhances both the physical properties and the water holding capacity (Soegiman, 1982).Theapplication of cocopeat and vermicompost showed significant effect on seedling length probably due to the synergistic combination of both factors in improving the physical conditions of the media and nutritional factors (Sahni *et al*., 2008). However, the air filled porosity (AFP), easily available water (EAW) and aeration of vermicompost

and FYM were not at the recommended level which in turn limit the root growth and lowered the water holding capacity. Therefore, the potting mixturealong with soil, vermicompost and cocopeat is more suitable than vermicompost alone because of the better physical properties and enhanced nutrient level.

Table 3: Effect of planting mixture and seed sowing orientation on seedling length in *balanitesroxburghii*

Seedling length (cm)												
	2022				2023				Pooled			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_1	21.00	49.67	40.67	**37.11**	19.67	55.00	43.00	**39.22**	20.67	52.67	42.00	**38.44**
M_2	35.67	51.33	45.33	**44.11**	37.33	50.67	46.00	**44.67**	37.00	51.33	46.00	**44.78**
M_3	43.67	64.33	55.33	**54.44**	41.67	63.00	52.33	**52.33**	42.67	64.00	54.33	**53.67**
M_4	22.33	40.33	31.33	**31.33**	20.00	42.33	33.33	**31.89**	21.33	41.67	32.33	**31.78**
M_5	26.67	44.67	33.67	**35.00**	29.00	43.33	36.33	**36.22**	28.00	44.33	35.33	**35.89**
M_6	24.33	42.33	34.00	**33.56**	25.67	37.00	30.33	**31.00**	25.33	39.67	32.33	**32.44**
M_7	26.67	45.00	35.00	**35.56**	26.67	45.00	35.00	**35.56**	26.67	45.00	35.00	**35.56**
	28.62	**48.24**	**39.33**		**19.67**	**55.00**	**43.00**	**39.22**	**28.81**	**48.38**	**39.62**	
	S.Em. ±	**CD @ 1 %**			**S.Em. ±**	**CD @ 1 %**			**S.Em. ±**	**CD @ 1 %**		
Factor A	0.741	2.121			0.773	2.115			0.571	1.636		
Factor B	0.485	1.389			0.506	1.450			0.374	1.071		
A XB	1.283	3.674			1.339	3.836			989	2.834		

M1: Soil:Sand: FYM 2:1:1
M2: Soil: Coco peat: FYM 2:1:1
M3: Soil: Coco peat: Vermicompost 2:1:1
M4: Soil: Paddy husk : FYM : 2:1:1
M5: Soil : Paddy husk : Vermicompost : 2:1:1
M6: Soil : Saw dust : FYM 2:1:1
M7: Soil : saw dust : vermicompost 2:1:1
S2 : Seeds laid horizontally
S1 : Seed laid vertically with stalk end downwards
S3 : Seeds laid vertically with stalk end upwards

Seedling vigour index

Seedling vigour index was affected significantly by potting mixture and seed sown orientation(Table 4). Seedling vigour index isdepends on seed germination and seedling length. Even though highest germination (84.00%) recorded in Soil:Sand:FYM but this media not provide the nutrients for seedling development since poor nutrient supply by this media, but potting mixture Soil:cocopeat:vermicompost provide more nutrients for seedling development in early stages recorded high seedling vigour index (4561) and high vigour seedlings may survive even in unfavorable conditions and survival rate is also high compare to others.

The probable reasons for the best performance of soil, cocopeat and vermicompost are high organic matter content which increases the water and nutrient holding capacity of the

medium, which improve the water utilization capacity of plant. Vermicompost is reported to have bioactive principles which are considered to be beneficial for root growth and greater root initiation, higher germination, increased biomass, enhanced growth and development (Bachman and Metzger, 2008) and also balanced composition of nutrients present in the media (Zaller 2007). The higher available well decomposed organic matter (Vermicompost) may preserve soil humidity, increase nutrient content and improve soil structure which increase water absorption and maintains the cell turgidity, cell elongation and increase respiration at optimum level, leading to favourable seed sprouting. Vermicompost mixed with soil affects properties of soil physics, chemistry and biology, since organic matter acts as glue for soil aggregate and source of soil nutrient (Soepardi, 1983). Vermicompost granules may develop soil aggregate. Vermicompost and soilmay decrease fluctuation of soil temperature. Further, seed germination and root growth becomes easier to the particular depth so that plant grows well and may absorb more water and nutrient. Organic matter may also improve nutrient availability and improve phosphorous absorption (Karama and Manwan, 1999). All these factors are favourable for seed germination and ultimate by increasing seed germination percent, seedling length, seedling vigour index and minimizing the days taken for initiation of germination. Combined application of soil, vermicompost and cocopeat in the treatment T3 showed significant effect on germination, seedling growth and vigour of seedling. This may be due to the synergistic combination of both factors in improving physical condition of the media and nutritional factors (Sahni et al., 2008).

Table 4: Effect of planting mixture and seed sowing orientation on seedling vigour index in *balanitesroxburghii*

Seedling vigour Index												
	2022				2023				Pooled			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_1	888	3989	3403	**2760**	807	4471	3656	**2978**	848	4230	3529	2869
M_2	1248	3493	3247	**2663**	1209	3500	3392	**2700**	1229	3497	3320	2682
M_3	1470	4568	4113	**3384**	1263	4554	3903	**3240**	1367	4561	4008	3312
M_4	567	1910	1754	**1410**	418	1948	1807	**1391**	493	1929	1781	1401
M_5	738	2215	2005	**1653**	778	2227	2096	**1700**	758	2221	2051	1677
M_6	695	2300	2132	**1709**	694	1785	1936	**1472**	695	2043	2034	1591
M_7	844	2579	2286	**1903**	844	2579	2000	**1808**	844	2579	2143	1855
	921	**3008**	**2706**		**859**	**3009**	**2684**		**890**	**3009**	**2695**	

	S.Em.±	CD @ 1 %		S.Em.±	CD @ 1 %		S.Em.±	CD @ 1 %	
Factor A	43.534	124.684		152.894	152.894		35.684	102.200	
Factor B	28.500	81.625		34.948	100.093		23.361	66.906	
A XB	75.404	219.959		92.464	92.464		61.807	177.016	
M1: Soil:Sand: FYM 2:1:1 M3: Soil: Coco peat: Vermicompost 2:1:1 M5: Soil : Paddy husk : Vermicompost : 2:1:1 M7: Soil : saw dust : vermicompost 2:1:1 S1 : Seed laid vertically with stalk end downwards					M2: Soil: Coco peat: FYM 2:1:1 M4: Soil: Paddy husk : FYM : 2:1:1 M6: Soil : Saw dust : FYM 2:1:1 S2 : Seeds laid horizontally S3 : Seeds laid vertically with stalk end upwards				

Conclusion

Based on the results, it can be concluded that depulped seeds sown in the potting media of Soil:Sand:FYM (2:1:1), with seeds laid vertically (stalk end upwards), yield good germination. However, seedlings from this mix should be transplanted to a different potting medium for better growth and development.Alternatively, when depulped seeds are sown in a mix ofSoil:Cocopeat:Vermicompost with the seeds laid horizontally, there is no need to transplant them to another medium until they are transplanted to the main field. This method allows for better establishment of the seedlings.

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