COIR PITH: A COST EFFECTIVE ALTERNATIVE GERMINATION MEDIUM FOR RUBBER SEED (*HEVEA BRASILIENSIS*)

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The germination medium plays a key role in the production of good quality planting materials in rubber and strongly influences the sustainability of rubber plantation industry. To study the effect of different media on germination and survival of seeds, an experiment was laid out using river sand as control and several other media such as raw coir pith, leached coir pith, new wood shavings, 6 months old wood shavings, raw saw dust, dried saw dust, rice husk, paddy straw, coconut leaf with a layer of soil, dried litter, rock powder, directly on the seed bed (without medium), soilrite and heaping of seeds on floor without any medium. All the germination associated parameters were significantly affected by the germination medium. In the experiment germination bed with river sand, leached coir pith, dried saw dust and soilrite recorded significantly higher germination percentage compared to all other germination media. The cost comparison of different germination medium showed that around 75 per cent of cost can be reduced by using coir pith as germination medium compared to river sand. Considering the cost, availability and germination capacity, leached coir pith is considered as an ideal seed germination medium for rubber.

Keywords: Coir pith, Economics, Germination medium, Germination percentage, *Hevea brasiliensis*

INTRODUCTION

In rubber (*Hevea brasiliensis*), the seeds are mainly used for raising root stock for bud grafting of clones. Root stocks are very important which influence the performance and yield of budded plants (Daud, 2012). The successful production of healthy and vigorous root stock in rubber to a great extent depends on the use of good quality seeds and management practices followed in the nursery. It is estimated that the direct contribution of quality seeds to the total production is about 15-20 per cent depending upon the crop and it can be further raised up to 45 per cent with efficient management of other inputs (Poonia, 2013).

In India, the rubber fruits normally ripen in July- September months and seeds are popped off. Rubber seeds are classified as recalcitrant that are susceptible to deterioration and lose their germination capacity in a short time (Papadakis *et al*., 2005; Dias *et al*., 2010). Fresh and healthy seeds collected from the field can be kept under shade for about seven days without much loss of viability.

In rubber nursery, sowing of seeds in the germination bed has been considered as

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a better practice than direct sowing of seeds in the seedling nursery. Direct sowing results in vacant spaces in the seed bed if the seed germination percentage is low. The use of pre germinated seeds result in successful establishment of plants at uniform spacing and reduces cost of production in the seedling nursery. In germination bed, river sand is usually used as the medium and recently the scarcity in availability and increasing cost of river sand has necessitated the use of alternative media in rubber nurseries. Hence, different materials are used as germination media in nurseries according to the local availability with considerable variation in germination percentage. Apart from this, the days taken for germination are also considered as an index for relating the quality of the sprouted seeds (Mavi *et al*., 2010). In rubber plantations, the seed availability is decreasing year after year and it is important to use materials which will not adversely affect the germination of seeds. An experiment was therefore initiated to evaluate different materials as germination media for rubber. The effect of germination media on germination percentage, time taken for germination and the survival of sprouted seeds were studied.

MATERIALS AND METHODS

The experiment was conducted at Rubber Research Institute of India, Kottayam (9^0 32'N latitude, 76^0 36'E longitude and 73 m above MSL) during the period August - September 2011 and was repeated during September – October 2011. Fresh polyclonal seeds were used for both the experiments. The experiments were laid out in complete randomised design with fifteen treatments and two replications. The treatments included germination bed with river sand (control), raw coir pith, leached coir pith (leached by exposing to sun and rain for 6 months), new wood shavings, six months old wood shavings, raw saw dust, dried saw dust (6 months old), rice husk, paddy straw, coconut leaf with a layer of soil, dried litter, rock powder, directly on the seed bed (without medium), soilrite and heaping of seeds on floor. Individual beds of 90 cm width and 10-15 cm height were made with soil and different media were spread over the bed at a thickness of 5 cm. The seed sowing and the management practices of germination beds were adopted as per recommendations of the Rubber Board.

Radicle protrusion of 2 cm was scored as germination and seeds which did not germinate within two to three weeks were considered as weak seedlings (Edgar, 1958) and discarded. Data on germination was recorded by counting germinated seeds from the date of first germination at two days intervals up to 20^{th} day of germination. Weather parameters during the period of experiments were recorded (Fig.1). Germination associated parameters were calculated by using the following formulas:

a) **Germination capacity/percentage:** Calculated as the per cent of germinating seeds at the end of the experiment in relation to the total number of seeds per bed.

b) **Imbibition period:** Time taken for the commencement of germination from the day of sowing.

c) **Rate of germination**: Number of days taken to attain 50 per cent germination capacity (Hartmann *et al.,* 1997).

Time taken to attain 50 per cent emergence (T_{50}) of seeds was calculated according to Farooq *et al*. (2005).

$$T_{50} = ti + \frac{\left\{\left(\frac{N}{2}\right) - ni\right\}(ti - tj)}{ni - nj}$$

where, N is the final number of germination and *ni*, *nj* are cumulative number of seeds germinated by adjacent counts at times *ti* and *tj* when $n<N/2<nj$.

d) Mean germination time (MGT): Calculated based on the formula suggested by Ellis and Roberts (1981)

$$MGT = \frac{\Sigma Dn}{\Sigma n}$$

where, *n* is the number of seeds which are germinated on day *D*, and *D* is number of days counted from the beginning of germination.

e) The germination value (GV): Calculated according to Hossain *et al.* (2005) by the following formula

$$GV = (EDGs/N) \times GP/10$$

where, GP - Germination percentage at the end of the experiment

DG - Daily germination speed obtained by dividing the cumulative germination percentage by the number of days since sowing

EDGs - Total germination obtained by adding every DGs value obtained from the daily counts

N - Total number of daily counts starting from the first germination, 10 is constant

The water holding capacities of different medium were estimated using standard procedure (Viji and Rajesh, 2012). Economics of germination media which showed significantly higher germination percentage for an area of 1 m^2 was worked out.

For statistical analysis, the data of germination per cent was transformed to arcsin. All data were subjected to analysis of variance.

RESULTS AND DISCUSSIONS

Imbibition period

The data pertaining to imbibition period showed a significant difference in the days taken for initiation of germination among the treatments (Table 1).

In the first experiment, the seed bed with dried saw dust (more than six months old) showed earlier germination *i.e.*, least imbibition period of seven days compared to all other medium and was on par with leached coir pith (8 days). The medium sand, raw coir pith, soilrite and seed bed without medium had the imbibition period of nine days and the period was statistically comparable with leached coir pith. In the 2nd experiment, the medium soilrite recorded the least imbibition period of eight days and was comparable with the seeds germination in sand, leached coir pith, old saw dust, raw saw dust, six months old wood shavings, new wood shavings, dried litter, straw and rock powder. In both the experiments, the germination method of heaping seeds on floor registered the highest imbibition period of 15 days.

In majority of the treatments in the 2nd experiment, germination was initiated within 10 days of sowing where as in the 1st experiment the imbibition period within 10 days was observed only in a few treatments. The delay in the germination of seeds in the 1st experiment might be due to the distinct variations in the weather parameters during the experiment period (Fig.1). During the

Table 1. **Effect of germination media on imbibition period (days)**

Sl. No.	Treatments	Imbibition period	
		Experiment 1	Experiment II
1	Germination bed with river sand (control)	9	9
2.	Coir pith (leached)	8	9
3.	Raw coir pith	9	10
4.	Dried saw dust (more than 6 months old)	7	9
5.	Raw saw dust	11	9
6.	Wood shavings (old)	11	9
7.	Wood shavings (new)	13	9
8.	Rock powder	11	9
9.	Straw	13	9
10.	Rice husk	13	11
11.	Coconut leaf with a layer of soil	12	13
12.	Soilrite	9	8
13.	Dried litter	13	9
14.	Without medium (soil alone)	10	10
15.	Without any medium (heaping seeds)	15	15
	SE	0.632	0.632
	CD (P≤0.05)	1.35	1.35

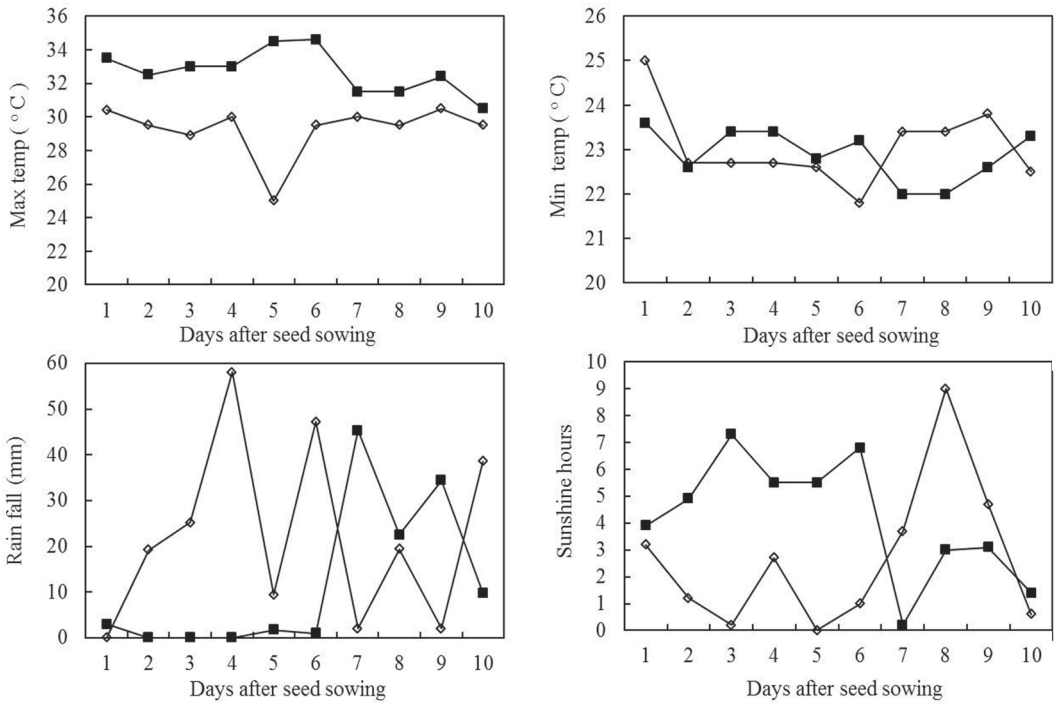

Fig.1. Weather parameters during the experiment

initial six days of the 1st experiment heavy rain fall was received almost every day and the total amount of rain fall during this period was 159 mm. The minimum and maximum temperature and light availability were comparatively lower during the period which might have resulted in high imbibition period. In the 2nd experiment, little or no rain fall occurred during this period (5.8 mm). The ecological conditions prevailing in the habitat affect the germination of seeds and the temperature and light are the most important factors that promote the seed germination when water is available. The critical temperature level for seed germination is different for different species or cultivar. Larcher (1975) reported that the tropical plants show the optimum germination temperature between 15 to 30 ^{0}C.

Germination capacity

Germination capacity of rubber seeds in different media is presented in Table 2. Considerable variations were observed in the germination of seeds in different media and in both the experiments the germination bed with river sand, leached coir pith, old saw dust and soilrite showed significantly higher germination percentage compared to other media. Heaping of seeds on the floor recorded the lowest germination percentage. Generally, the emergence losses of seeds in the soil are not due to germination failure, but failure of the seeds to emerge above soil surface (Halmer and Bewley, 1984).

According to Nzekwe *et al*. (2013), the physical and chemical properties of the growth medium have a profound effect on germination of seeds. Ndor *et al.* (2012)

Table 2. **Effect of germination media on germination percentage of seeds**

	Treatments	Germination (%)	
		Experiment 1	Experiment II
1.	Germination bed with river sand (control)	62.0 (51.97)	57 (49.04)
2.	Coir pith (leached)	65.5 (54.05)	56 (48.47)
3.	Raw coir pith	36.0 (36.88)	28 (31.94)
4.	Dried saw dust (more than 6 months old)	63.5 (52.85)	57 (49.04)
5.	Raw saw dust	56.0 (48.46)	49 (44.44)
6.	Wood shavings (old)	46.0 (42.72)	39 (38.66)
7.	Wood shavings (new)	16.0 (23.57)	18 (25.08)
8.	Rock powder	51.5 (45.88)	48 (43.87)
9.	Straw	42.0 (40.41)	35 (36.28)
10.	Rice husk	12.0 (20.27)	18 (25.08)
11.	Coconut leaf with a layer of soil	15.0 (22.75)	11 (19.35)
12.	Soilrite	63.5 (52.85)	55 (47.89)
13.	Dried litter	10.7 (19.01)	12 (20.21)
14.	Without medium (soil alone)	54.5 (47.60)	45 (42.14)
15.	Without any medium (heaping seeds)	7.5 (15.88)	5 (12.86)
SE		0.757	1.015
CD (P≤0.05)		2.28	3.06

* Transformed values are given in the parenthesis

reported that good seed material contact and firmness of the medium contributed better moisture availability to trigger better germination process. The data on water holding capacity (WHC) of different medium showed that the water retention capacity of the medium was in the order coir pith (937.33%) > saw dust (271.62 %) > soilrite (250.50 %) > dried litter (243.35%) > paddy straw (239.78%) > wood shavings (227.68 %) > coconut leaf with a layer of soil (91.4%) > rice husk (86.19%) > soil (51.90 %) > river sand (30.48%) > rock powder (11.91%). Coir pith recorded the highest WHC which was more than three times the WHC of all other media. Even though the WHC of river sand was less, the germination capacity was on par with leached coir pith, old saw dust and soilrite. River sand was sufficiently firm and dense to hold the seeds in place during germination and it retained enough moisture for germination (Ekwu and Mbah, 2001). In the case of coconut leaf, dried litter, rice husk and paddy straw, the poor seed-material contact and firmness of the medium contributed to the lower germination percentage.

In this experiment, the seeds sown in raw coir pith, raw saw dust and new wood shavings had low germination percentage compared to seeds sown in leached coir pith, dried saw dust and old wood shavings even though the physical properties were almost same. The release of soluble tannin related phenolic compounds from raw coir pith (Thampan, 2000), raw saw dust and new wood shavings might have contributed to the low seed germination percentage. The process of germination starts by the uptake of water by the dry seed (imbibition) and is

Table 3. **Effect of germination media on rate of germination (days)**

Sl. No.	Treatments	Days taken to germination	
		Experiment 1	Experiment II
1	Germination bed with river sand (control)	14.17	12.60
2.	Coir pith (leached)	13.87	13.25
3.	Raw coir pith	15.32	13.77
4.	Dried saw dust (more than 6 months old)	13.61	13.00
5.	Raw saw dust	15.33	13.43
6.	Wood shavings (old)	15.36	12.55
7.	Wood shavings (new)	16.17	13.00
8.	Rock powder	15.37	12.67
9.	Straw	16.38	13.98
10.	Rice husk	16.06	14.92
11.	Coconut leaf with a layer of soil	15.61	13.00
12.	Soilrite	14.12	12.30
13.	Dried litter	15.98	12.37
14.	Without medium (soil alone)	15.36	13.30
15.	Without any medium (heaping seeds)	16.93	16.00
	SE	0.27	0.68
	CD (P≤0.05)	0.57	1.44

completed when a part of the embryo, usually the radicle, penetrate the seed coat (Bewley, 1997). The change in water potential due to the release of ions from the medium hinders water absorption by the seeds and thus reduces the rate of germination (Hadas, 1977).

A high germination capacity is indicative of high vigour and high field emergence compared with a low germination capacity and will have a higher competitive ability (Pourhadian and Khalehpour, 2010).

Rate of germination (Time taken to attain 50 per cent germination capacity)

Significant difference in rate of germination was observed among treatments (Table 3). In the 1st experiment, seeds in germination bed with old saw dust recorded significantly higher rate of germination or the least time taken to attain 50 per cent germination (13.61 days) compared with other media and was on par with leached coir pith, river sand and soilrite. In the second experiment, the rate of germination was the highest in soilrite and was comparable with all other media except rice husk, straw, raw coir pith, and heaping of seeds on floor. The environmental factors prevailing at the time of experimentation might have contributed to the shorter germination time in the 2nd experiment. Shorter the time taken to achieve 50 per cent germination, greater the germination energy and higher the germination speed (Willan, 1985). Rapid and uniform emergence is an essential pre requisite to increase the quality of the planting material, yield potential and ultimately profit in crops (Hassanein, 2010).

Table 4. **Effect of germination media on mean germination time (days)**

Sl. No.	Treatments	Days taken to germination	
		Experiment 1	Experiment II
1.	Germination bed with river sand (control)	14.82	13.03
2.	Coir pith (leached)	15.30	14.05
3.	Raw coir pith	16.47	14.13
4.	Dried saw dust (more than 6 months old)	15.35	14.15
5.	Raw saw dust	16.40	13.6
6.	Wood shavings (old)	16.90	13.91
7.	Wood shavings (new)	16.95	14.10
8.	Rock powder	16.52	13.30
9.	Straw	17.12	13.51
10.	Rice husk	16.99	15.35
11.	Coconut leaf with a layer of soil	16.92	13.75
12.	Soilrite	14.88	12.06
13.	Dried litter	16.09	13.45
14.	Without medium (soil alone)	16.52	14.96
15.	Without any medium (heaping seeds)	17.90	17.33
	SE	0.32	0.53
	CD (P≤0.05)	0.68	1.12

In both experiments, sand, old sawdust, leached coir pith and soilrite showed consistently higher rate of germination.

Mean germination time

The mean germination time was significantly affected by different germination media in both experiments and ranged from 12.06 to 17.90 days (Table 4). In the 1st experiment mean germination time was the lowest in river sand and was on par with leached coir pith, old saw dust and soilrite and all other medium showed a significantly higher mean germination time of more than 16.09 days. In the 2nd experiment the medium soilrite and river sand (control) recorded the least mean germination time, but the mean germination time of river sand (control) was on par with all other treatments (13.03-14.96 days) except rice husk, soil alone and heaping method. The mean germination time is significantly related to seed emergence (Matthews and Hosseini, 2006). The lower and more prolonged germination period might have contributed to the higher mean germination period in the 1st experiment.

Germination value

The germination value varied from 0.15 to 12.76 and 0.11 to 14.61 among the treatments in the first and second experiment respectively (Table 5). In the 1st experiment, the medium river sand, leached coir pith, old saw dust and soilrite recorded significantly higher germination values compared to all other treatments, while in the 2nd experiment the medium river sand and soilrite showed the higher germination values. In both the experiments the lowest germination value was found in heaping

Table 5. **Effect of germination media on germination value**

Sl. No.	Treatments	Germination value	
		Experiment 1	Experiment II
1.	Germination bed with river sand (control)	12.40	14.25
2.	Coir pith (leached)	11.68	10.77
3.	Raw coir pith	2.93	3.10
4.	Dried saw dust (more than 6 months old)	11.33	11.91
5.	Raw saw dust	8.58	9.75
6.	Wood shavings (old)	4.98	5.84
7.	Wood shavings (new)	0.73	1.34
8.	Rock powder	6.86	11.32
9.	Straw	4.87	5.02
10.	Rice husk	0.41	1.13
11.	Coconut leaf with a layer of soil	0.61	0.54
12.	Soilrite	12.76	14.61
13.	Dried litter	0.40	0.75
14.	Without medium	7.17	6.91
15.	Without any medium (heaping seeds)	0.15	0.11
	SE	0.72	0.70
	CD (P≤0.05)	1.54	1.50

Table 6. **Comparative cost analysis (₹ m^{-2})**

Treatments	Quantity required (kg)	Cost (₹)
Sand ₹ $3kg^{-1}$	15 (reuse 50% in the next year)	22.5
Coir pith ₹ $0.40kg^{-1}$	7	2.80
Soilrite ₹ $31kg^{-1}$	6 (reuse 50% in the next year)	93
Saw dust (₹ $0.60kg^{-1}$)	6	3.60

method of germination. The high germination value is indicative of high vigour of the seeds (ISTA, 1995).

Economic analysis

Comparative cost analysis of the germination medium with significantly higher germination percentage is given in Table 6. The cost of sand, coir pith, soilrite and saw dust was around ₹ 3.0, 0.40, 31.0 and 0.60 per kg respectively. Among the different materials used as germination medium, coir pith was the cheapest material and is available in abundance in Kerala as a by-product of the coir industry. In the case of sand and soilrite around 50 per cent of the material can be reused as germination medium during the next year. Hence, the quantity of sand, coir pith, soilrite and saw dust required for an area of 1 m^2 was 15, 7, 6 and 6 kg and the cost was ₹ 22.5, 2.80, 93.0 and 3.60 respectively. From this study it was clear that around 75 per cent of cost of germination medium can be reduced by using coir pith as medium compared to river sand.

During the later stages of the experiment the incidence of fungal growth was observed in germination media. The media river sand, coir pith, soilrite, rock powder, wood shavings, soil and coconut leaf with soil did not show any fungal infestation. In the study it was noticed that even though the medium saw dust recorded the higher per cent of seed germination, there was incidence of fungal growth at the end of the experiment. It was reported that sawdust had the tendency of having fungal growth when it is used as medium and suggested to limit its use to the impermeable seeds (Adam *et al*., 1998 and Charloq *et al.*, 2013).

CONCLUSION

The results of the study indicated that the germination associated parameters such as germination percentage, imbibition period, mean germination time, rate of germination and germination value of seeds were influenced by germination media. Germination bed with river sand, leached coir pith, dried saw dust and soilrite recorded significantly higher germination percentage compared to other media studied. The comparative cost analysis showed that around 75 per cent of cost of germination medium can be reduced by using coir pith compared to river sand. Hence, coir pith is the most suitable seed germination medium for rubber.

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