



## Effect of Rooting Media on Rooting Potential of Phalsa (*Grewia asiatica* L.) Stem Cuttings at Different Planting Dates

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### Abstract

Phalsa (*Grewia asiatica* L.) is the chief underutilized fruit crop of India which can be propagated by rooting of hardwood cuttings but it depends upon the environmental conditions and the rooting media used for it. Hence, a research study was conducted at the Horticultural Experimental area, Khalsa College, Amritsar during 2023-24 to determine the effect of rooting media on the rooting potential of phalsa stem cuttings at different planting time. The treatments included three planting times (Last week of June, July and August) and four types of rooting media (Canadian peat moss, sterilized river sand and soil (3mix) (1:1:1) (v/v/v); Fermented pine bark and sterilized river sand (Bark mix) (1:1) (v/v); Soil and sterilized river sand (Peat mix) (2:1) (v/v) and soil) laid out in factorial randomized design replicated thrice. The results of the study stated that the June planting showed maximum results in all the observed parameters in terms of sprouting, rooting in terms of root number, length and root weight and vegetative traits including shoot formation, diameter and shoot weight respectively under the soil alone and mixed with the other rooting media.



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### Keywords

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### Introduction

Phalsa (*Grewia asiatica* L.) is a commercially nutritional promising berry of family Tiliaceae. It is still considered as an underutilized fruit crop acquiring the chromosomal status of  $2n = 181$ . It is a minor fruit crop native to south Asia widely confined to tropical and subtropical regions. Phalsa is a fruit packed with nutritional attributes. The fruits are reported to have anti-diabetic, anti-hyperglycemic, radioprotective, antimicrobial, antipyretic, anti-fungal, analgesic, antioxidant, anticancerous and anti-viral effects.<sup>2</sup> In India Although phalsa is propagated through seed

but due to its long juvenile phase its multiplication through hardwood cuttings is also possible. The findings of<sup>3</sup> revealed that the time of cutting preparation in phalsa greatly affected the root initiation and the prevailing environment and nutrient availability shows variation in the rooting success survival percentage of cuttings.<sup>4</sup> Studies on the effect of season on rooting of stem cuttings have also been conducted in various plant species.<sup>5</sup> Rooting media plays an integral part in the plant propagation creating a suitable environment, acts as a reservoir for plant nutrients, hold plant available

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water and provide a means for gaseous exchange and good anchorage for the plants resulting in the successful root production.<sup>6</sup> However, the research results related to phalsa cuttings have not yet produced a media composition that can accelerate the multiplication process which necessitates its further studies. Hence, the present research was undertaken with an objective to study the effect of rooting medium and planting time on the performance of phalsa cuttings under sub tropical conditions.

### Materials used and Methodology

#### Cutting Procurement and their Planting

Hardwood cuttings of phalsa 20 cm long were collected from 4 to 5 year old plants and were planted in the polybags of size of 16×10 inches filled with four rooting media (R1- Canadian peat moss, sterilized river sand and soil (3mix) (1:1:1) (v/v/v); R2- Fermented pine bark and sterilized river sand (Bark mix) (1:1) (v/v); R3- Soil and sterilized river sand (Peat mix) (2:1) (v/v); R4- Soil (Control) and planted at the three timings (T1- Last week of June; T2- Last week of July; T3- Last week of August ) times comprising of twenty treatment combinations. During plantation, 8 x 8 inch sized were filled with the respective rooting media with holes on the bottom and sides of polythene bags for drainage of water. The cuttings were planted on the prescribed planting timings with 2/3rd length of the cuttings buried in the media, leaving 1/3rd part exposed to the environment.

#### Methodology

Number of days to sprouting were recorded by observing daily and calculating their mean. Sprouting per cent was calculated at 30 DAP (Days after planting) by dividing number of sprouted cuttings by total cuttings planted multiplied by 100. Survival percentage was worked out by dividing survived cuttings by total planted ones and their percentage was taken. Total number of shoots formed were calculated per plant for all the five selected and later on averaged. Shoot fresh weight was taken on electronic balance with average calculated in grams. Using destructive method all the five tagged shoots were collected and placed in paper bags and were dried in oven at 60° C till constant weight for calculation in grams of shoot dry weight. Roots arising from the base of the cuttings were counted. Root length was measured from the base to growing tip of root in centimetres with the help of scale and later on averaged.

### Data Collection and Statistical Analysis

Data on sprouting and growth parameters of cuttings were analysed were calculated and processed in MS-Excel. The statistical analysis of data which comprised of 20 treatment combinations with three replications were analyzed by Factorial Randomized Block Design ( $p \leq 0.05$ ) using R software. 4.1.1. Test of least significance was calculated at the 5% level of significance.

### Results and Discussion

#### Days to Sprouting

The earlier sprouting (4.74 days) was reported in the cuttings planted in the last week of July followed by August planting commencing 5.58 days while the sprouting was late within (6.63 days) in the cuttings planted in last week of June. Planting time in phalsa cuttings play a significant role in the sprouting. Variation in planting time exhibits variation according to various places and their environmental condition. Monsoon planting time initiated earlier sprouting due to the higher humidity.<sup>7</sup> The research findings of<sup>8</sup> revealed earlier sprouting of phalsa cuttings in July. The results of<sup>9</sup> also reported earlier sprouting of phalsa cuttings in the month of August. Among various rooting media the mixture of soil and sterilized river sand initiated earlier (4.21 days) sprouting followed by 5.78 days in the cuttings under mixture of Canadian peat moss, sand and soil. The cuttings planted under the fermented pine bark and sterilized river sand sprouted late within (6.49 days). Rooting media of soil and sand initiated earlier germination as the sand when added to soil facilitated proper drainage and aeration for gaseous exchange.<sup>9</sup> The interaction between planting time and rooting media showed that the treatment combination  $T_3R_4$  (August planting in soil) resulted in earlier sprouting (4.03 days) while  $T_1R_4$  (June planting in soil) sprouted late.

#### Sprouting Percent

Maximum (61.35 %) sprouting of cuttings was noticed in the planting time of June which reduced to a greater extent (8.91 %) in the August planting and further (5.24 %) in July planting time of cuttings. The increased sprouting in June might be due to the several factors such as temperature, humidity, light and nutrient availability to cuttings which served as the favourable conditions to enhance the percentage of sprouted cuttings.<sup>10</sup> According to<sup>4</sup> buds start to force out in the rainy season which acts as an optimal

period for rooting of many species for maximizing the sprouting. The cuttings planted in only soil resulted in the maximum (30.22 %) followed by the media mixture of fermented pine bark and river sand while the least sprouting (21.78 %) was reported from the cuttings planted in the media mixture of Canadian peat moss, sterilized river sand and soil. Increased sprouting might be due to increased aeration and drainage leading to increased porosity that promotes root growth and development, also that nutrients in the soils are mostly found at top soil. According to<sup>11</sup> top soil supported the sprouting percentage of cuttings probably due to the high level of moisture content of the soils. Interaction of planting time and rooting media exerted significant variations with maximum (70.47 %) sprouting in the treatment combination of T1R4 (June planting of cuttings in soil) while the lowest (4.83 %) was generated from T3R3 (August planting under soil and river sand mixture).

#### Survival Percent

Maximum plant survival (32.79 %) was observed in the cuttings planted on last week of July whereas (26.35 %) plant survival was witnessed in the cuttings planted on last week of June. The cuttings planted on the last week of August sprouted but did not survive at all. Augmentation of cell elongation and division in appropriate environmental conditions pertaining to light, temperature and nutrient availability to the rooting led to the maximum survival percentage of cuttings.<sup>12</sup> Better partitioning coefficient in cuttings was observed higher when planted on 30th July planting time.<sup>13</sup> No survival of phalsa cuttings in the month of August might be due to the high humidity along with the excess of rain but these results are in contradiction to the findings of<sup>14</sup> who recorded that the maximum survival percentage of cuttings in phalsa recorded under August planting time. Among the various rooting media maximum survival (42.55 %) was noted in R<sub>1</sub> (Canadian peat moss+ sterilized river sand +soil) followed by a huge reduction in R<sub>3</sub> (Soil+sterilized river sand) and R<sub>2</sub>(Fermented pine bark+ sterilized river sand) with 15.82 and 13.02 per cent while minimum survival (8.53 %) was found in the cuttings planted in R<sub>4</sub> (Soil). Various factors such as oxygen, water and nutrient availability interacts within a growth medium affects the survival.<sup>15,6</sup> The success in survival with Canadian peat moss+ sterilized river sand + soil could be attributed to the positive interaction of aeration and water-holding capacity creating a well balance of oxygen and

water-holding capacity thus promoting oxygen availability, transpiration, nutrient uptake, growth and aeration resulted in better survival as compared to other rooting media.<sup>16</sup> Also, the fine-texture and small pores in peat moss when combined with river sand created a good aerated environment which might have increased respiration at the base of the cuttings thus increasing the survival rate.<sup>17</sup> Significant interaction was noticed among the treatment combination of planting time and rooting media with maximum (99.67%) survival in T<sub>2</sub>R<sub>1</sub> (July planting in Canadian peat moss+ sterilized river sand +soil) while no survival was reported in T<sub>2</sub>R<sub>3</sub> (July planting in soil + sterilized river sand) and in the August planting under all the rooting media.

#### Shoots Per Cutting

Maximum shoot formation (1.00) was registered in the cuttings from the June planting than July planting with (0.94) shoots respectively. The cuttings planted in August failed to survive hence no data can be generated from it. The prevailing congenial environmental conditions in terms of temperature and humid sunny days might have influenced the vegetative growth as well as the emergence of a higher number of shoots per plant.<sup>18</sup> The research findings of<sup>19</sup> also reported the same in phalsa cuttings. The research outcome of non formation of shoots due to failure of survival in August planting cuttings are in contradiction with the findings of<sup>20</sup> who showed the highest shoot development in the cuttings of phalsa when planted in the month of August.<sup>21</sup> Fermented pine bark when mixed with sterilized river sand (Bark mix 1:1) produced the plants with more ( 0.91) shoots followed with a slight difference (0.89 and 0.88) shoot production from the cuttings planted in only soil and Canadian peat moss mixed with river sand and soil. The least (0.84) shoots were generated from the cuttings planted in media mixture of soil and sand. (Figure-1). The increased vegetative properties was noticed when sand was used with the pine bark the content of nitrogen, carbon and C/N % was increased due to the good content of C and N in their content of chemical compounds might be the reason for greater shoot formation.<sup>22</sup> The interaction effect of planting time and rooting media cannot show variation among them regarding shoot formation except the August planting cuttings which due to non survival did not form any shoot.

### Shoot Fresh Weight Per Cutting (g)

Maximum fresh shoot weight (0.94 g) was observed in the cuttings planted on the last week of June followed in a decreasing trend attaining (0.63 g) in the cuttings of July plantation. Due to the failure of cuttings in the August planting data on shoot fresh weight could not be generated. The best performance in terms of shoot fresh weight might be due to the congenial environmental conditions assuring the proper hydrolysis of enzymes and allowing the availability of efficient supply of nutrients leading to vigorous growth with higher shoot weight.<sup>11</sup> The rooting media mixture of Canadian peat moss in combination with river sand and soil resulted in the production of the heaviest shoots (1.03 g) with reduction in other media being the lightest (0.54 g) shoots produced in the cuttings planted only in the soil. Superiority of Canadian peat moss can be attributed to high cation exchange capacity and appropriate moisture holding capacity of the medium.<sup>21</sup> The suitability of physical and chemical characteristics pertaining to density, porosity, air capacity, pH, electrical conductivity, cation exchange capacity and carbon to nitrogen ratio peat is a suitable medium for planting most horticultural species as reported by.<sup>23</sup> The treatment combination registered significant variation with the heaviest (1.24 g) shoots in T<sub>1</sub> R<sub>1</sub> (June planting under Canadian peat moss in combination with river sand and soil) whereas the lightest (0.29 g) shoots were from the plants under T<sub>2</sub> R<sub>4</sub> (July planting under only soil).

### Shoot Dry Weight (G)

It is evident from the data that June planting of cuttings produced the shoots with higher (0.42 g) dry weight whereas, the minimum (0.21 g) shoot dry weight was obtained under the July planting time. No data generation in August planting time due to the failure of cuttings. The favourable environmental conditions producing vigorous growth of the shoots might be responsible for higher dry matter in them.<sup>4</sup> Regarding the rooting media Canadian peat moss, sterilized river sand and soil (3mix) (1:1:1) (v/v/v) sterilized river sand and soil resulted in the highest (0.60 g) dry matter content followed by (0.44g) in the media mixture of fermented pine bark and sterilized river sand (Bark mix) (1:1) (v/v) with the lowest (0.27 g) from the cuttings planted in the only soil. The increase in photosynthetic rate with increasing moisture and chlorophyll content was translated into plant growth.<sup>21</sup> This was probably the reason

why the sole top soil and river sand treatments with higher photosynthetic efficiency resulted in seedlings that had larger stem volumes, indicating better dry matter production and accumulation.<sup>22,23</sup> The highest (0.37g) dry matter was noticed in the treatment combination Of T<sub>1</sub> R<sub>3</sub> (June planting under river sand and soil) whereas the lowest (0.11 g) shoot dry weight was from the plants under T<sub>2</sub> R<sub>4</sub> (July planting under only soil).

### Number of Leaves Per Cutting

On comparing the data for different cuttings it is clear that the more (6.92) leaves were produced in the cuttings planted in the last month of June while the lesser (3.42) were counted from the cuttings of July planting. Data from August planting cannot be generated due to the failure of the cuttings to survive. Increased leaf production by plants raised through cuttings planted in the last week of June can be attributed to maximum aerial as well as underground growth acquired by the cuttings resulting in more uptake of nutrients and accumulation of photosynthates due to the favorable environment which aids in the contribution to the vigorous growth with more leaves.<sup>24</sup> Regarding rooting media fermented pine bark when mixed with sterilized river sand (Bark mix 1:1) resulted in the raised plants with maximum (4.83) leaves following a decreasing trend (4.11 and 2.96 ) in the plants from the cuttings planted in only soil and Canadian peat moss mixed with river sand and soil. Lesser (2.88) leaf production were from the plants generated from the cuttings planted in the media mixture of soil and sterilized river sand. Increase in the content of chemical compounds pertaining to nitrogen, carbon and C/N % I along with ideal air filled porosity in the media mixture of pine bark and sterilized river sand might have contributed to the vigorous plant growth with a good leaf production<sup>17</sup>. With significant variation among the treatment combination maximum leaf formation (8.83) leaves were produced in T<sub>1</sub>R<sub>2</sub> (June planting under fermented pine).

### Roots Per Cutting

Maximum number of roots (6.83) was counted in the plants raised from the cuttings planted on last week of June while lesser (3.52) root production was witnessed in cuttings of July planting. The data on root formation through August planting time cannot be presented due to the failure of their survival. Divergence in rooting is due to the environmental

circumstances. Congenial prevailing environmental conditions might be the reason for more root production during June.<sup>4</sup> The studies of<sup>24</sup> revealed the increased rooting in the rainy season months. The research outcome of the present investigation regarding failure of the cuttings and absence of roots from the August planting time is in contradiction with the findings of<sup>8</sup> who reported that the phalsa cuttings enhanced rooting percentage observed in the period of mid-August. In context to the rooting media maximum (4.14) roots were produced from R<sub>1</sub> (Canadian peat moss+ sterilized river sand +soil) followed by a reduction in R<sub>2</sub> (Fermented pine bark+ sterilized river sand) with 4.05 roots while lesser (2.59) were from the cuttings planted in R<sub>3</sub> (Soil and sterilized river sand). Due to the adequate physical and chemical characteristics pertaining to density, porosity, air capacity, water holding capacity, pH, electrical conductivity, cation exchange capacity and carbon to nitrogen ratio, peat might have acted as a suitable medium along with river sand and soil for enhanced root formation.<sup>20</sup> Significant interaction was registered among the treatment combination of planting time and rooting media with maximum (7.33) root formation in T<sub>1</sub>R<sub>1</sub> (June planting in Canadian peat moss+ sterilized river sand +soil) while no rooting was reported in the combination of August

planting cuttings under all the rooting media used in the research study.

#### Root Length (cm)

The maximum (20.41 cm) of average root length per cutting was found in the June planting time followed by a reduction indicating (11.25 cm) in July planting time. The data regarding planting time of August did not predict any data due to failure of cuttings. The favourable environmental conditions in terms of suitable temperature, humidity, sunshine and adequate aeration in the month of June might have helped in the better absorption of water by root, which subsequently increase in length.<sup>22</sup> The cuttings planted in only soil produced the longest (17.39 cm) roots followed by (10.79 cm) under the fermented pine bark when mixed with sterilized river sand (Bark mix 1:1). The shortest (6.51 cm) roots were produced from the cuttings planted in Canadian peat moss mixed with soil and river sand. Interaction of time of planting and treatments was found to be significant. Longest root (28.90 cm) was reported from the treatment combination T<sub>1</sub>R<sub>4</sub> (June planting under only soil) while the shortest (10.27 cm) roots were from T<sub>1</sub>R<sub>1</sub> (June planting in Canadian peat moss mixed with soil and river sand).

**Table 1: Effect of rooting media on sprouting and survival in phalsa cuttings at different planting dates**

Treatment	Days to sprouting	Sprouting percent	Survival percent	Shoots per cutting
T <sub>1</sub>	6.63	61.35	26.35	1.00
T <sub>2</sub>	4.74	5.24	32.79	0.94
T <sub>3</sub>	5.58	8.91	0.00	0.00
SEm±	0.05	0.12	0.12	0.02
C.D. (5%)	0.15	0.35	0.36	0.05
R <sub>1</sub>	5.78	21.78	42.55	0.88
R <sub>2</sub>	6.49	25.00	13.02	0.91
R <sub>3</sub>	4.21	23.67	15.82	0.84
R <sub>4</sub>	6.11	30.22	8.53	0.89
SEm±	0.06	0.14	0.14	0.02
C.D. (5%)	0.17	0.40	0.41	0.06
T <sub>1</sub> R <sub>1</sub>	7.03	54.67	27.17	1.00
T <sub>1</sub> R <sub>2</sub>	6.27	54.77	18.13	1.00
T <sub>1</sub> R <sub>3</sub>	5.00	65.50	46.00	1.00
T <sub>1</sub> R <sub>4</sub>	8.20	70.47	14.10	1.00
T <sub>2</sub> R <sub>1</sub>	5.07	5.17	99.67	1.00
T <sub>2</sub> R <sub>2</sub>	7.10	10.17	20.13	1.00

T <sub>2</sub> R <sub>3</sub>	0.00	0.00	0.00	0.00
T <sub>2</sub> R <sub>4</sub>	6.10	4.97	10.67	1.00
T <sub>3</sub> R <sub>1</sub>	5.23	5.50	0.00	0.00
T <sub>3</sub> R <sub>2</sub>	6.10	10.07	0.00	0.00
T <sub>3</sub> R <sub>3</sub>	6.93	4.83	0.00	0.00
T <sub>3</sub> R <sub>4</sub>	4.03	15.23	0.00	0.00
SEm±	0.10	0.24	0.24	0.03
C.D. (5%)	0.30	0.70	0.71	0.10

T<sub>1</sub>-Last week of June; T<sub>2</sub>-Last week of July; T<sub>3</sub>-Last week of August; R<sub>1</sub>- Canadian peat moss, sterilized river sand and soil (1:1:1); R<sub>2</sub>- Fermented pine bark and sterilized river sand (Bark mix) (1:1); R<sub>3</sub>- Soil and sterilized river sand (2:1) ; R<sub>4</sub>- Soil (Control)

**Table 2: Effect of rooting media on shoot and root traits in phalsa cuttings at different planting dates**

Treatment	Shoot fresh weight (g)	Shoot dry weight (g)	Leaves per cutting	Roots per cutting	Root length (cm)
T <sub>1</sub>	0.94	0.42	6.92	6.83	20.41
T <sub>2</sub>	0.63	0.21	3.42	3.52	11.25
T <sub>3</sub>	0.00	0	0.00	0.00	0.00
SEm±	0.01	0.05	0.09	0.24	0.25
C.D. (5%)	0.04	0.16	0.27	0.69	0.74
R <sub>1</sub>	1.03	0.60	2.96	4.14	6.51
R <sub>2</sub>	0.67	0.38	4.83	4.05	10.79
R <sub>3</sub>	0.83	0.44	2.88	2.59	8.48
R <sub>4</sub>	0.54	0.27	4.11	4.02	17.39
SEm±	0.02	0.06	0.11	0.27	0.29
C.D. (5%)	0.05	0.19	0.31	0.80	0.86
T <sub>1</sub> R <sub>1</sub>	1.24	0.36	5.13	7.33	10.27
T <sub>1</sub> R <sub>2</sub>	0.76	0.31	8.83	6.67	18.57
T <sub>1</sub> R <sub>3</sub>	1.18	0.34	7.07	6.33	23.90
T <sub>1</sub> R <sub>4</sub>	0.58	0.18	6.63	7.00	28.90
T <sub>2</sub> R <sub>1</sub>	1.12	0.37	2.90	4.33	8.50
T <sub>2</sub> R <sub>2</sub>	0.45	0.15	5.03	4.67	13.13
T <sub>2</sub> R <sub>3</sub>	0.00	0.00	0.00	0.00	0.00
T <sub>2</sub> R <sub>4</sub>	0.29	0.11	4.97	4.33	22.53
T <sub>3</sub> R <sub>1</sub>	0.00	0	0.00	0.00	0.00
T <sub>3</sub> R <sub>2</sub>	0.00	0	0.00	0.00	0.00
T <sub>3</sub> R <sub>3</sub>	0.00	0	0.00	0.00	0.00
T <sub>3</sub> R <sub>4</sub>	0.00	0	0.00	0.00	0.00
SEm±	0.03	0.11	0.19	0.47	0.51
C.D. (5%)	0.08	0.07	0.30	1.38	1.49

T<sub>1</sub>-Last week of June; T<sub>2</sub>-Last week of July; T<sub>3</sub>-Last week of August; R<sub>1</sub>- Canadian peat moss, sterilized river sand and soil (1:1:1); R<sub>2</sub>- Fermented pine bark and sterilized river sand (Bark mix) (1:1); R<sub>3</sub>- Soil and sterilized river sand (2:1) ; R<sub>4</sub>- Soil (Control)



(a) Canadian peat moss, sterilized river sand and soil(3mix) (1:1:1)



((b) Fermented pine bark and sterilized river sand(bark mix) (1:1)



(c) soil and sterilized river sand (Peat mix) (2:1)



(d) Soil (control)

**Fig. 1: Shoot formation in plants under various rooting media planted on last week of June**

**Conclusion**

The present research study provides preliminary results concerning growth of phalsa cuttings in different rooting media at various time intervals. Our findings suggest to multiply phalsa through cuttings at the last week of June. However, a declining

trend in the vegetative growth was observed over time, more probably due to the change in climatic conditions. The outcomes suggest the soil to be a good option when mixed with other rooting media. Due to the differences in rooting success as affected by the rooting media and planting dates

it is therefore recommended that rooting of the cuttings be optimized under both the factors before commercialization which needs further studies .

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#### Conflict of Interest

The authors do not have any conflict of interest.

#### Data Availability Statement

This statement does not apply to this article.

#### Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval.

#### Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

#### Permission to Reproduce Material from other Sources

Not Applicable

#### Author Contributions

- **Amarjeet Kaur:** Conceptualization of research work and Designing of work, Preparation of manuscript.
- **Krishankant Malgotra:** Execution of field/Lab experiments and execution of data.
- **Amarjeet Kaur and Krishankant Malgotra:** Analysis of data and interpretation Both authors read and approved the final manuscript.

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