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The standardization of method and time of propagation in pear (*Pyrus communis* L.)

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Abstract
The present investigation on the standardization of method and time of propagation in Pear (*Pyrus communis* L.) was experimented during ten different months, *viz*. 08th June, 08th July, 07th August, 06th September, 06th October, 05th November, 05th December, 04th January, 3th February and 05th March with three different methods, i.e. tongue grafting, air layering, and hardwood cutting during the year 2022-23. It was observed that among all propagation methods, tongue grafting was found to be most superior in terms of the percent success at 70 days (62.00%), scion diameter (0.84 cm) of cutting and grafting, rootstock diameter (1.14 cm) of cutting and grafting, number of branches, leaf area, survival % than air layering in terms of the days to bud intake, number of branches, plant height, number of primary roots and number of secondary roots.

Keywords: Standardization of method, propagation, pear, *Pyrus communis* L.

Introduction
Pear (*Pyrus communis* L.) belongs to family Rosaceae with somatic chromosome number is 2 n = 34 and it's originated from China. Pear is an important temperate fruit crop but it's grown under both temperate and sub-tropical regions. Pear is the rich source of nutrients like Protein, Carbohydrate, Fat, Dietary fiber, Potassium, Sodium, Iron, Magnesium and Vitamin C. It reduces the risk of cardiovascular disease, weight loss, promotes gut health, anti – inflammation action, and anti-cancer effects etc. Most of the pear cultivars chilling requirements is 1200 hours below 7 °C and low chilling pear needs 150 hours below 7 °C and chilling requirement of European pear is 1200-1500 hour's below 7 °C. Pear can resist biotic and abiotic stress such as soil pest, soil diseases, extreme temperature, nutritional stresses by better anchorage (Hartmann *et al.*, 2011) [6]. Plant propagation plays a very important role in order to morphological quality and free from abiotic and biotic stresses, requiring new advances and propagation improvements in new releases of rootstocks and scions (Jacob *et al.* 2002) [7]. Pear can be propagated by different techniques, *viz*. tongue grafting (Hartmann *et al.* 2011) [6], hard wood cuttings (Francescatto *et al*, 2010) [4] and air layering (Singh *et al.* 2010) [16]. While, choosing a particular technique for propagation of pear, the time and method of operation should be taken into consideration as the success of each method vary from region to region due to variation in agro climatic conditions (Rani *et al.* 2015) [13].

Materials and Methods
The present experiment was carried out at the Horticulture Research Center of Division of Fruit Science, College of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut of Uttar Pradesh, India during 2022-23 to find out best method and time of propagation in pear. The site of experiment is situated in the sub-tropical zone at latitude of 29.01^0N and longitude of 77.45^0E. The altitude of the place is 297 meters from mean sea level. Meteorological data during the period of investigation is presented showed that mean annual maximum and minimum temperature was 29.92 °C and 17.38 °C, respectively. Three methods of vegetative propagation namely tongue grafting, air layering, and hard wood cutting were tried for present study and ten months, *viz*. 08th June, 08th July, 07th August, 06th September, 06th October, 05th November, 05th December, 04th January, 3th February and 05th March were selected for propagation. The experiment was performed in a Factorial Randomized Block Design with three replications. The biometrical observations were recorded on five randomly selected plants of each replication to assess the vegetative characters, i.e. days to bud intake,

percent success at 70 days (%)**,** Scion diameter (cm) of cutting and grafting, rootstock diameter (cm) of cutting and grafting, number of branches, number of leaves, and leaf area.

Results and Discussion

Days to bud intake

Different time and methods of propagation had significant influence on days to bud intake in pear. Data presented in the Table- 1 indicates that among different time and methods of propagation sprouted earliest (26.71 days) as compared to hard wood cutting (26.81 days) and tongue grafting (32.67 days). Among different months of grafting, air layering, and hard wood cutting took less time (25.09 days) in the month of February, while plants in December took the maximum time (31.51 days) for bud intake. Similar observations were also reported by Afshari *et al*., (2011) [1] in rapeseed (*Brassica napus* L.) genotypes.

interaction effect of method and time had a significant effect on the number of days required for bud intake showed that hard wood cutting performed in February induced significantly early bud sprouting (17.07 days), whereas air layering plants took minimum time (17.20 days) in July and tongue grafting plants took minimum time (24.47 days) in February. However, hard wood cutting took the maximum time (35.00 days) in December, air layering (36.27 days) in March, and tongue grafting (39.00 days) in June. These findings are quite comparable to the findings obtained by Jaipal *et al.* (2021) [8] in low chill peach cv Shan-i-Punjab under semi-arid irrigated ecosystem and Rymbai *et al.* (2023) [15] in Himalayas pear (*Pyrus pashia*).

Percent success at 70 days (%)

The percent success was affected significantly by the method and time of propagation in pear. Data presented in Table- 2 that the tongue grafting technique showed higher (48.67%) sprouting percent than air layer in (30.67%) and hard wood cutting (34.67%). In respect to time of propagation, February month was found to be most successful in getting higher sprouting success than other months of propagation. The highest sprouting (58.89%) irrespective of tongue grafting, air layering and hard wood cutting was recorded in February. Whereas, the minimum (21.11%) percent success at 70 days showed in the month of November.

Table 1: Effect of time and method of vegetative propagation on the days to bud intake

Month	Tongue grafting	Air layering	Hard wood cutting	Mean
08th June	39.00	19.87	25.47	28.11
08th July	38.73	17.20	27.20	27.71
07th August	38.00	19.47	27.87	28.44
06th September	35.20	23.67	29.20	29.36
06th October	34.00	24.40	31.13	29.84
05th November	32.07	27.00	32.60	30.56
05th December	27.27	32.27	35.00	31.51
04th January	26.80	33.20	18.87	26.29
03th February	24.47	33.73	17.07	25.09
05th March	31.20	36.27	23.67	30.38
Mean	32.67	26.71	26.81	
Factors		**C.D.**	**S.E(d)**	**S.E(m)**
Propagation method		0.170	0.085	0.060
Time		0.310	0.154	0.109
Interaction (Method × Time)		0.537	0.267	0.189

Table 2: Effect of time and methods of vegetative propagation on the percent success at 70 days (%)

Month	Tongue grafting	Air layering	Hard wood cutting	Mean
08th June	33.33	36.67	26.67	32.22
08th July	40.00	43.33	30.00	37.78
07th August	43.33	40.00	33.33	38.89
06th September	33.33	36.67	36.67	35.56
06th October	23.33	13.33	33.33	23.33
05th November	43.33	6.67	13.33	21.11
05th December	53.33	23.33	10.00	28.89
04th January	66.67	30.00	46.67	47.78
03th February	80.00	36.67	60.00	58.89
05th March	70.00	40.00	56.67	55.56
Mean	48.67	30.67	34.67	
Factors		**C.D.**	**S.E(d)**	**S.E(m)**
Propagation method		3.963	1.975	1.396
Time		7.236	3.606	2.550
Interaction (Method × Time)		12.534	6.245	4.416

The interaction effect of method and time of propagation on success also showed significant difference. Tongue grafting recorded highest sprouting (80.00%) in the month February, air layering recorded the highest success (43.33%) in July and hard wood cutting recorded the highest success (60.00%) in February. Least sprouting was recorded in plants propagated through tongue grafting, air layering, and hard wood cutting during October (23.33%), November (6.67%), and November (13.33%) respectively. The results are in conformity with the findings of Jaipal *et al.* (2021) [8] in peach, Rymbai *et al.* (2023)

[15] in Himalaya's pear (*Pyrus pashia*) and Pektas *et al.* (2009) [11] in pear.

Scion diameter (cm) of cutting and grafting

It is evident from the data recorded that tongue grafting, air layering, and hard wood cutting performed in different months had significant effect on diameter of scion stem at 30,60 and 90 days in the Table-3. Irrespective of time of operation, the maximum scion diameter was recorded in tongue grafting than air layering. The scion diameter of vegetatively propagated plants was found to be maximum in February and minimum scion diameter was recorded in June at 30, 60 and 90 days.

The combined effect of method and time of vegetative propagation on diameter of scion shoot was found to be significant. The tongue grafting had significantly maximum scion stem diameter in the month of February followed by January and air layering had recorded maximum scion diameter in the month of July followed by August. Tongue grafting recorded minimum scion diameter in the month June at 30, 60 and 90 days. Air layering technique of propagation at 30 and 60 days performed minimum scion diameter in the month of December and at 90 days in January. Scion diameter (cm) of cutting and grafting supports the findings of Jaipal *et al.* (2021) [8], Rymbai *et al.* (2023) [15], Mngomba *et al.* (2012) [9], Pektas *et al.* (2009) [11].

Table 3: Effect of time and methods of vegetative propagation on the scion diameter (cm) of cutting and grafting at 30, 60 and 90 days

Month	Tongue grafting			Air layering			Mean		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
08th June	0.56	0.63	0.66	0.64	0.69	0.74	0.60	0.66	0.70
08th July	0.60	0.65	0.70	0.73	0.77	0.81	0.66	0.71	0.76
07th August	0.61	0.67	0.72	0.68	0.73	0.78	0.65	0.70	0.75
06th September	0.64	0.69	0.78	0.66	0.71	0.76	0.65	0.70	0.77
06th October	0.63	0.71	0.81	0.62	0.68	0.68	0.63	0.70	0.75
05th November	0.68	0.73	0.86	0.56	0.61	0.66	0.62	0.67	0.76
05th December	0.73	0.79	0.91	0.50	0.55	0.61	0.62	0.67	0.76
04th January	0.76	0.81	0.94	0.52	0.57	0.58	0.64	0.69	0.76
03th February	0.79	0.84	0.97	0.56	0.60	0.65	0.68	0.72	0.81
05th March	0.71	0.76	0.82	0.60	0.65	0.70	0.66	0.71	0.76
Mean	0.67	0.73	0.82	0.61	0.66	0.70			
Factors	**C.D.**			**S.E(d)**			**S.E(m)**		
Propagation method	0.007	0.003	0.020	0.003	0.001	0.010	0.002	0.001	0.007
Time	0.016	0.006	0.045	0.008	0.003	0.022	0.005	0.002	0.015
Interaction (Method Time)	0.022	0.009	0.063	0.011	0.004	0.031	0.008	0.003	0.022

Rootstock diameter (cm) of cutting and grafting

In the present study, all techniques of vegetative propagation had significant effect on rootstock diameter at 30, 60 and 90 days in the Table-4. The maximum rootstock diameter recorded under tongue grafting as compared to hard wood cutting except to 60 days. The maximum rootstock diameter showed significant variation when tongue grafting and hard wood cutting was performed in February, followed by January and minimum recorded in June months of the year at 30, 60 and 90 days.

In respect to interaction of time and propagation method, tongue grafting and hard wood cutting recorded maximum rootstock diameter in February followed by January, and minimum rootstock diameter recorded in the month of June at 30, 60 and 90 days except to 90 days of air layering. These results are in accordance with the findings of Ahmad *et al.* (2018) [2] in wild type pear, Brar and Khehra (2017) [3], Pektas *et al.* (2009) [11] in pear and Picolotto *et al.* (2010) [12] in peach.

Table 4: Effect of time and methods of vegetative propagation on the Rootstock diameter (cm) at 30, 60 and 90 days

Month	Tongue grafting			Hard Wood cutting			Mean		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
08th June	0.88	0.94	1.02	0.90	0.95	1.01	0.89	0.95	1.01
08th July	0.90	0.97	1.05	0.94	0.99	1.08	0.92	0.98	1.07
07th August	0.95	1.02	1.08	0.98	1.03	0.98	0.97	1.03	1.03
06th September	0.96	1.05	1.10	0.92	1.13	0.95	0.94	1.09	1.03
06th October	0.97	1.08	1.16	0.97	1.19	0.93	0.97	1.13	1.04
05th November	1.02	1.11	1.19	1.00	1.21	0.94	1.01	1.16	1.07
05th December	1.05	1.13	1.24	1.06	1.25	1.07	1.06	1.19	1.16
04th January	1.14	1.20	1.30	1.08	1.31	1.18	1.11	1.26	1.24
03th February	1.21	1.27	1.34	1.14	1.35	1.22	1.17	1.31	1.28
05th March	1.11	1.16	1.24	0.96	1.13	1.06	1.04	1.15	1.15
Mean	1.02	1.09	1.17	1.00	1.15	1.04			
Factors	**C.D.**			**S.E(d)**			**S.E(m)**		
Propagation method	0.007	0.002	0.027	0.003	0.001	0.013	0.002	0.001	0.009
Time	0.015	0.005	0.060	0.008	0.002	0.029	0.005	0.002	0.021
Interaction (Method Time)	0.022	0.007	0.084	0.011	0.003	0.041	0.008	0.002	0.029

Number of branches

Table-5 indicated the tongue grafting recorded maximum number of primary branches than hard wood cutting plants and air layering. When tongue grafting, hard wood cutting and air layering were performed in different months, maximum number of primary branches was recorded in plants propagated in February and minimum number of primary branches per plants was observed in the month of September and October at 30, 60 and at 90 days in October.

Interaction between time and method significantly influenced number of primary branches on each propagated plant. Tongue grafting produced maximum number of primary branches in the month of February at 30, 60 and 90 days. Tongue grafting recorded minimum number of primary branches in June month at 30, 60 days and in August at 90 days. Air layering was noted to be maximum layered plants in July at 30, 60 and 90 days and minimum observed in the month of December at 30 and 90 days except 60 days. Hard wood cutting observed maximum number of branches in the month of February and minimum number of primary branches in recorded in the month of October at 30, 60 and 90 days. Similar observations were also reported by Ahmad *et al.* (2018) [2], Rymbai *et al.* (2023) [15], Gurung *et al.* (2020) [5] in Citrus reticulata and Rymbai *et al.* (2022) [14] in Anti-desma bunius that a higher number of leaves was associated with higher number of branches and shoot performance in vegetatively propagated plants.

Table 5: Effect of time and methods of vegetative propagation on the number of branches at 30, 60 and 90 days

Month	Tongue grafting			Air layering			Hard Wood cutting			Mean		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
08th June	0.80	1.07	3.07	1.60	2.53	3.93	1.13	1.80	2.47	1.18	1.80	3.16
08th July	0.87	1.27	2.47	2.80	3.53	5.20	1.00	1.60	2.20	1.56	2.13	3.29
07th August	1.07	1.47	2.07	1.20	2.53	4.00	0.87	1.13	1.93	1.04	1.71	2.67
06th September	1.27	1.67	2.47	0.93	1.53	3.07	0.73	0.93	1.40	0.98	1.38	2.31
06th October	1.47	2.07	2.67	0.80	1.47	2.13	0.67	0.73	1.13	0.98	1.42	1.98
05th November	1.60	2.47	2.73	0.60	1.40	1.87	0.93	0.87	2.00	1.04	1.58	2.20
05th December	1.67	2.67	3.07	0.27	1.13	1.53	1.13	1.27	2.40	1.02	1.69	2.33
04th January	1.93	2.80	3.67	0.60	1.27	2.13	1.93	2.00	2.67	1.49	2.02	2.82
03th February	2.33	2.93	4.73	0.80	1.53	2.47	2.53	3.13	3.27	1.89	2.53	3.49
05th March	1.93	2.87	3.87	1.00	1.73	3.33	1.20	2.00	2.87	1.38	2.20	3.36
Mean	1.49	2.13	3.08	1.06	1.87	2.97	1.21	1.55	2.23			
Factors	**C.D.**						**S.E(d)**			**S.E(m)**		
Propagationmethod	0.134	0.085		0.183			0.067	0.042	0.091	0.047	0.030	0.065
Time	0.244	0.155		0.334			0.122	0.077	0.167	0.086	0.055	0.118
Interaction (Method × Time)	0.423	0.269		0.579			0.211	0.134	0.289	0.149	0.095	0.204

Number of leaves

In the present study, the maximum number of leaves per plant was recorded in air layering, followed by hard wood cutting and tongue grafting. The plants propagated in July in the present investigation showed comparatively more number of leaves than the plants propagated in others months at 30 and 90 days and June at 60 days in the Table-6.

The interaction between time and method of vegetative propagation on number of leaves was found to be significant. The tongue grafted and hard wood cutting plants had maximum number of leaves in the month of February and minimum number of leaves was recorded in the month of October at 30, 60 and 90 days. The technique air layering produced maximum number of leaves in July at 30 days and in June at 60 and 90 days. In air layering, minimum leaves recorded in the month of February at 30, 60 and 90 days. Same findings were also observed by Ahmad *et al.* (2018) [2], Rymbai *et al.* (2023) [15] in Himalaya's pear (*Pyrus pashia*) and Mozumder *et al.* (2017) [10] in plum.

Table 6: Effect of time and methods of vegetative propagation on the number of leaves at 30, 60 and 90 days

Month	Tongue grafting			Air layering			Hard Wood cutting			Mean		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
08th June	10.07	15.07	22.47	24.87	38.53	45.93	11.33	18.13	25.33	15.42	23.91	31.24
08th July	8.87	13.53	20.73	28.47	31.20	35.47	10.93	15.73	22.33	16.09	20.16	26.18
07th August	7.07	11.73	18.13	22.27	30.33	37.93	9.53	13.73	20.13	12.96	18.60	25.40
06th September	5.13	9.93	17.53	18.87	25.33	32.13	8.13	11.13	18.33	10.71	15.47	22.67
06th October	4.93	7.93	14.73	13.27	20.93	27.73	6.73	9.53	16.13	8.31	12.80	19.53
05th November	8.53	11.53	18.40	10.87	15.53	22.33	7.73	10.13	16.73	9.04	12.40	19.16
05th December	11.53	14.93	22.33	8.07	11.73	18.93	8.73	12.93	20.33	9.44	13.20	20.53
04th January	14.33	17.93	25.27	4.07	8.33	15.00	13.33	17.73	23.93	10.58	14.67	21.40
03th February	17.53	22.73	27.53	2.47	6.93	13.67	18.73	24.13	30.73	12.91	17.93	23.98
05th March	15.33	17.33	23.93	4.27	8.53	15.33	13.13	20.93	28.33	10.91	15.60	22.53
Mean	10.33	14.27	21.11	13.75	19.74	26.45	10.83	15.41	22.23			
Factors	**C.D.**						**S.E(d)**			**S.E(m)**		
Propagationmethod	0.143	0.282		0.722			0.071	0.140	0.360	0.050	0.099	0.254
Time	0.260	0.514		1.318			0.130	0.256	0.657	0.092	0.181	0.464
Interaction (Method × Time)	0.451	0.891		2.283			0.225	0.444	1.138	0.159	0.314	0.804

Leaf area

Present study of leaf area differed significantly due to time and method of vegetative propagation in the Table-7. As evident from the result, maximum leaf area of was recorded in tongue grafting as compared to air layering and hard wood cutting at 30, 60 days except 90 days. Irrespective of method of propagation, the plants propagated in June had the highest leaf area and minimum leaf area was recorded in plants propagated in the month of October and November at 30, 60 days but July had maximum leaf area and March had minimum leaf area at 90 days.

Both factor time and method of propagation was also found to be significant at 30, 60 and 90 days. It is evident from the data that among the different months of tongue grafting produced maximum area in the month of February at 30 days and in January at 60 and 90 days. Minimum leaf area recorded in tongue grafting at 30 days and in June at 60 and 90 days. July month produced maximum leaves area in air layering at 30, 60 and 90 days. Minimum leaf area recorded in air layering during February at 30 days and March at 60 and 90 days. Cutting in the month of February produced maximum leaves area at 30, 60 and 90 days. Minimum leaf area recorded in hard wood cutting during November at 30, 60 and 90 days. Similar results were also observed by Ahmad *et al.* (2018) [2] in rootstock of wild type pear.

Table 7: Effect of time and methods of vegetative propagation on the leaf area at 30, 60 and 90 days

Month	Tongue grafting			Air layering			Hard Wood cutting			Mean		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
08th June	6.18	9.46	12.74	6.85	10.95	15.05	6.09	10.19	14.29	6.37	10.20	14.03
08th July	6.07	9.91	13.74	7.13	11.23	15.33	5.85	9.95	14.05	6.35	10.36	14.37
07th August	5.98	9.81	13.65	5.99	10.09	14.19	5.35	9.45	13.55	5.77	9.78	13.80
06th September	5.51	9.61	13.71	5.85	9.95	14.05	5.05	9.15	13.25	5.47	9.57	13.67
06th October	5.45	9.28	13.11	5.73	9.83	13.93	4.93	9.03	13.13	5.37	9.38	13.39
05th November	6.07	10.17	14.27	5.49	9.59	13.69	4.55	8.65	12.75	5.37	9.47	13.57
05th December	6.27	10.37	14.47	5.31	9.41	13.51	5.77	9.87	13.97	5.78	9.88	13.98
04th January	6.34	10.49	14.59	4.99	9.09	13.19	6.13	10.23	14.33	5.84	9.94	14.04
03th February	6.39	9.63	12.93	4.85	8.95	13.05	6.61	10.71	14.81	5.93	9.76	13.60
05th March	6.00	9.55	13.11	4.79	8.89	12.99	5.75	9.85	13.95	5.51	9.43	13.35
Mean	6.03	9.83	13.63	5.70	9.80	13.90	5.61	9.71	13.81			
Factors	**C.D.**						**S.E(d)**			**S.E(m)**		
Propagationmethod	0.152		N/A		N/A		0.076	0.114	0.195	0.054	0.081	0.138
Time	0.278		0.418		N/A		0.138	0.208	0.355	0.098	0.147	0.251
Interaction (Method × Time)	0.481		0.725		1.236		0.240	0.361	0.616	0.169	0.255	0.435

Conclusion

Tongue grafting was found to be most superior in terms of the percent success at 70 days (62.00%), scion diameter (0.84 cm) of cutting and grafting, rootstock diameter (1.17cm) of cutting and grafting, number of branches, leaf area, survival % than air layering in terms of the days to bud intake, number of branches, plant height, number of primary roots and number of secondary roots. Based on results obtained in the present study, it can be concluded that tongue grafting performed during February was found to be the most appropriate propagation technique in pear under sub-tropical conditions of Western Uttar Pradesh. Therefore, the Tongue grafting can be adopted with great success in pear for propagating plants on commercial scale in Western Uttar Pradesh.

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