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ROOTING RESPONSE OF PEAR CV. PATHARNAKH AS INFLUENCED BY SIZE AND LENGTH OF CUTTINGS

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Abstract

An attempt was made to propagate the pear cv. Patharnakh through stem cuttings without any rooting hormonal treatments at the nursery of Department of Horticulture, Khalsa College, Amritsar during 2019. The cuttings were selected with three different lengths, *viz*. 20 cm (L_1), 30 cm (L_2), 40 cm (L_3), and 50 cm (L_4) and three types (T_1) apical, (T_2) sub-apical and (T_3) basal. The cuttings were planted in the nursery and observed for survival percentage, number of roots, shoots, leaves and their fresh and dry weight on 90 days after planting. The results revealed that the basal stem cuttings (T_3) with 50 cm length (L_4) was found to be the most suitable for propagation as compared to other types of cuttings. It proved to be the best in terms of minimum days to first sprouting (25.33), maximum sprouting percentage (61.66%), survival percentage (87.67%), rooting percentage (86.66%), number of roots per cutting (5.00), root length (10.50 cm), number of shoots per cutting (4.66), average shoot diameter (2.66 cm), number of leaves (32.00) and total leaf area (277.16 cm^2).

Key words: Pear, Cuttings, Apical, Basal, Sub-apical, Patharnakh, Survival, Rooting, Sprouting.

Introduction

The pear spp. belongs to the genus Pyrus and family Rosaceae. It ranks 2nd next only to apple in importance, acreage, production and varietal wealth among temperate fruits in India (Rehman *et al.,* 2014). It is less winter hardy due to which it can be grown in a wide range of climatic conditions, even in the warmer climates of subtropical regions. It can grow under wider temperature conditions ranging from minus 26° when dormant to as high as 45° during growth period (Chadha, 2001). Due to its high adaptability the cultivation of Asian pear now a day is expanding from temperate region to sub-tropical and tropical region with assured irrigation. In Punjab, 250-350 chilling hours are required for sand pear and semi soft pear cultivars (Sandhu *et al.,* 2007). Pear fruit is said to be consumed in diets because of low calorific value. It has high nutritional value with reasonable amounts of vitamins A, B, B_2, C and minerals like Na, K, P, Ca, Mg and Fe. It has a lot of fiber which give excellent results in the treatment of constipation, intestine inflammation and reduces the cholesterol in body and there by protects from various heart diseases. It also cures kidney stones and cystitis (Silva *et al.,* 2014). Its juice is sometimes used as the first juice introduced to infants (Vadivel and Janardhanan, 2005). Antioxidants present in them help to fight against many health problems improving immunity. Anti-carcinogen glutathione and antioxidants present in pears help in controlling the blood pressure. Due to the presence of grit cells in pear fruits regular consumption of it offers protection against colon cancer. Most of the vitamin C as well as the dietary fiber is contained within the skin of the fruit. Pears are consumed fresh, canned and as juice dried. The juice can also be used in jellies and jams, usually in combination with other fruits or berries. Pear leaves were smoked in Europe before tobacco was introduced. Patharnakh is a low chilling cultivar and is the leading cultivar of pear predominantly grown in Punjab state contributing more than 80% of pear production. There are various methods of propagation of fruit plants. Plants raised from seeds show a great variability with respect to tree vigor, precocity and quality of fruits. Therefore, vegetative propagation is utmost desirable to propagate true to type plants. Like most of the other fruit plants, the pear too is vegetatively propagated (Gill and Singh, 2014). In Patharnakh in order to have uniform and true to type plants planting material of hard wood cuttings are used for propagation. The cuttings are prepared during December from juvenile shoots and are kept for callusing for about a month and are planted in the nursery. True to type planting materials are scarce with in commercial growing belt. Availability of pear plants through certified nursery is also meagre. The success of rooting of cuttings depends on the factors such as cultivar and age of source tree, length and diameter of cuttings (Tworkoski and Takeda, 2007). Keeping these factors in view the present investigation was therefore carried out to standardize the size of cuttings

Materials and Methods

The present investigation Rooting response of pear cv. Patharnakh as influenced by size and length of cuttings was carried out in the nursery of Department of Horticulture, Khalsa College, Amritsar during the year 2018-2019. The cuttings were taken from healthy uniform sized branches of pear cv. Patharnakh, growing in the nursery of Department of Horticulture, Khalsa College, Amritsar. To determine the optimum length and position of the cuttings for vegetative propagation, a large number of cuttings were collected from 3.5 years old mother plants. After removal of the side branches and leaves the cuttings were made into 20 cm (L1), 30 cm

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(L2), 40 cm (L3), 50 cm (L4), T1 apical, T2 sub – apical and T3 basal based on the length the cuttings were graded into small medium and large. The cuttings were planted on the 15 cm high nursery beds of size of 10 x 1 m. The beds were prepared by incorporating a mixture of sand, soil and farmyard manure. While planting about 2/3rd length of the cutting were buried in the soil, leaving 1/3rd part exposed to the environment. The cuttings were planted 20 cm apart with row to row distance of 30 cm. The various observations regarding sprouting percentage, survival percentage, root, shoot and leaf formation were recorded. Field observations were statistically analysed by factorial Randomized Block Design.

Results and Discussion

Days to first sprouting (days)

It is evident from the data that cutting type and the length of pear cuttings significantly affected the days to first sprouting up to a certain limit. The cuttings of length 50 cm (L_4) recorded minimum number of days (30.11) for first sprouting. Maximum (49.11) days were taken by the cuttings of length L_1 respectively. Among the type of cuttings basal cuttings (T_3) recorded the minimum days (32.00) with the maximum (45.08) in T_1 (apical) type of cuttings. Significant interactions between the length and type of cuttings were observed during the analysis of data. Minimum days to first sprouting (25.33) were recorded in L_4T_3 while the maximum days (51.33) were recorded in L_1T_1. Earliness in sprouting might be due to the fact that there was better utilization of stored carbohydrates, nitrogen and other factors in larger cuttings as compared to smaller cuttings due to higher adventitious ability of juvenile characters. It has also been presumed that the sprouting behavior of stem cuttings varies with age, genotypes and physiological status of the mother plant, which might be one of the reason for early sprouting of basal cuttings (Chandramouli, 2001). The present findings are in agreement with the findings of Kathiravan *et al.* (2009) in Jatropha.

Table 1: Effect of cutting type and cutting length on number of days to first sprouting of pear cuttings cv. Patharnakh

Days to first sprout					
	Cutting length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1 – Apical	51.33	47.33	44.67	37.00	45.08
T2 -Sub – apical	49.00	29.67	29.00	28.00	33.91
T3- Basal	47.00	28.33	27.33	25.33	32.00
Mean	49.11	35.11	33.67	30.11	
		T	L	TL	
CD (p = 0.05)		1.38	1.59	2.76	

Sprouting percentage (%)

The maximum percentage of sprouting (52.11%) was observed in L_3 while the least (42.22%) was recorded in L_1. It is presumed that the small sized cuttings registered very poor growth and were inferior to medium and long sized cuttings. Medium and long sized cuttings might have got sufficient food material and hormones for induction of root and shoot. Significant interactions between the length and type of cuttings were observed during the analysis of data. Minimum sprouting (26.66%) were recorded in L_1T_2, while the maximum (61.66%) was recorded in L_1T_2. It might be due to higher adventitious ability of juvenile characters of larger cuttings as compared to smaller ones which have tender tissues with unsaturated latex and the higher content of metabolites like tannin, lignin etc which adversely lead to better sprouting. Similar findings were reported by Kaur and Kaur (2016) in pomegranate cv. Ganesh and Kathiravan *et al.* (2009) in Jatropha, Tewfik (2002) in nemaguard peach rootstock.

Table 2: Effect of cutting type and length on the sprouting (%) of pear cv. Patharnakh

Sprouting (%)					
	Cutting length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1- Apical	40.00	43.33	54.00	52.66	47.50
T2-Sub – apical	26.66	33.00	40.66	38.33	34.66
T3-Basal	60.00	58.00	61.66	61.33	60.25
Mean	42.22	44.77	52.11	50.77	
		T	L	TL	
CD (p=0.05)		0.97	1.12	1.95	

Rooting percentage (%)

According to data of rooting percentage the highest rooting (79.77%) was gained from L_4 while the least (42.22%) was in L_1. The basal cuttings generated roots ranging from 67.33 per cent which were maximum and the lowest rooting percentage (46.83) was with apical cuttings respectively. Significant interactions between the length and type of cuttings were observed regarding rooting percentage with maximum rooting percentage (86.66%) in L_4T_3, while the minimum (25.00%) was in L_1T_1. Poor rooting was observed with reduction in size of cuttings. Due to inadequate supply of nutrients in shorter cuttings resulted in poor performance in rooting. Hegde (1996) expressed that this might be due to higher adventitious ability of juvenile characters of larger cutting compared to smaller cuttings which are having tender tissues, with unsaturated latex and the higher content of metabolites like tannin, lignin etc. which adversely interfere with sprouting and root development. The results are in conformity with Koyuncu and Senel (2003) in rooting of black mulberry hardwood cuttings and Dick and Leakey (2006) in rooting potential of cherry.

Table 3: Effect of cutting type and length on the rooting (%) of pear cuttings cv. Patharnakh

Rooting (%)					
	Cutting length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1 – Apical	25.00	26.00	63.66	72.66	46.83
T2 - Sub – apical	29.66	44.66	75.00	80.00	57.33
T3-Basal	35.00	67.66	80.00	86.66	67.33
Mean	29.88	46.11	72.88	79.77	
		T	L	TL	
CD (p = 0.05)		1.55	1.79	3.10	

Number of roots per cutting

The data presented in Table 4.5 and Figure 4.5 indicated that the root number per cutting was significantly increased with the increase in the cutting length and type up to a certain limit. Among the length of cuttings, the highest number of primary roots (4.44) were recorded in L_4 followed by L_3 and L_2

with (3.55) and (2.66) roots respectively. It was observed that L_1 had minimum number of roots (1.66) per cutting. It has also been found that basal cuttings produced more roots (3.50) as compared to sub- apical and apical cuttings which registered 3.08 and 2.66 roots respectively. Significant interactions between the length and type of cuttings were observed regarding number of roots per cutting. Maximum roots (5.00) were recorded in L_4T_3, while the minimum (1.33) was recorded in L_1T_1. This pertains to the fact that in basal long cuttings initial high level of endogenous auxins and its oxidation enzyme promoted cell division and their elongation led to differentiation of cambial initials into root primordial and in the mobilization of reserve food material to sites of root initiation there by giving higher number of roots per cutting (Sharma 1999). The poor performance of small grade cuttings is also attributed to the reason that the cuttings are still under maturity and might be devoid of sufficient food material for induction of roots. These findings are in agreement with the research work of Reddy *et al.* (2008) in fig, Shukla *et al.* (2010) in peach, Adelson (2009) in olive and Kaur and Kaur (2016) in pomegranate cv. Ganesh.

Table 4: Effect of cutting type and length on number of roots per cutting of pear cv. Patharnakh

Root per cutting					
	Cutting length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1- Apical	1.33	2.33	3.00	4.00	2.66
T2- Sub – apical	1.66	3.00	3.33	4.33	3.08
T3- Basal	2.00	2.66	4.33	5.00	3.50
Mean	1.66	2.66	3.55	4.44	
		T	L	TL	
CD (p = 0.05)		NS	1.25	NS	

Fresh weight of roots (g)

The maximum fresh weight (0.69 g) was recorded in L_4 while the minimum (0.52g) was in L_1. The apical cuttings produced lower fresh weight of roots (0.35 g) as compared to basal cuttings (0.86 g) which was the maximum. Results of these findings are confirmed by De Oliveira *et al.* (2003) in peach, Koyuncu and Senel (2003) in black mulberry. Interaction between the length and type of cuttings regarding fresh weight of roots were found to be non-significant. The poor performance of small grade cuttings is also attributed to the reason that the cuttings are still under maturity and might be devoid of sufficient food material for induction of roots. Also, the shoots formed have reserve carbohydrates which start producing auxins which moves downward thereby accumulating in the lower portion of the cuttings. When the concentration reaches a threshold value, endogenous auxins at the extreme basal and start getting metabolized and signal the process of root initiation leading to good weight of roots (Kochhar *et al.,* 2005). The present findings are in line with their search study of Singh *et al.* (2013) and Kaur and Kaur (2016) in pomegranate cv. Ganesh.

Table 5: Effect of cutting type and length on the fresh weight (g) of roots of pear cuttings cv. Patharnakh

Fresh weight of roots (g)					
	Cutting length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1- Apical	0.17	0.30	0.40	0.53	0.35
T2- Sub – apical	0.63	0.70	0.80	0.68	0.70
T3- Basal	0.77	0.83	0.87	0.96	0.86
Mean	0.52	0.61	0.69	0.72	
		T	L	TL	
CD (p = 0.05)		NS	NS	NS	

Dry weight of roots (g)

The data indicated that the maximum dry weight (0.55g) was recorded in L_4. These treatments were at par with each other. It is clear from the data that the position of cuttings led to the variation in the dry weight of roots depicting 0.65g, 0.51g and 0.20 g with basal, sub-apical and apical respectively. Interaction between the length and type of cuttings regarding dry weight of roots were found to be non-significant. Increase in dry weight of roots might be due to the fact that the increase in the root number and length of roots resulted in higher accumulation of dry matter. Results are in agreement with the findings of Kathiravan *et al.* (2009) in Jatropha and Tewfik (2002) in nemaguard peach rootstock.

Table 6 : Effect of cutting type and length on dry weight (g) of roots of pear cv. Patharnakh

Dry weight of root (g)					
	Cutting length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1 – Apical	0.07	0.13	0.23	0.36	0.20
T2 – Sub – apical	0.46	0.50	0.53	0.54	0.51
T3 – Basal	0.59	0.60	0.66	0.74	0.65
Mean	0.37	0.41	0.47	0.55	
		T	L	TL	
CD (p=0.05)		NS	NS	NS	

Number of shoots per cutting

The data pertaining to the number of shoots depicted that the cutting length and type had little significant effect on shoot production. The maximum number of shoots (4.00) were registered from the cuttings of 50 cm (L_4) while the minimum shoots were produced from cuttings with length of 20 cm (L_2). Among cutting types minimum number of shoots (2.41) were obtained from apical followed by sub- apical and basal cuttings with 2.75 and 3.08 cuttings. Interaction between the length and type of cuttings regarding shoot number were found to be non-significant. Shoots were formed much earlier than roots. Shoots thus formed earlier due to reserve carbohydrates, start producing auxins which moves downward, thereby accumulating in the lower portion of the cuttings, when the concentration reaches a threshold value, endogenous auxins at the extreme basal end start getting metabolized and signal the process of shoot initiation. The research findings of Singh and Singh (2016) in Sweet orange cv. Malta. are in support with the present findings.

Table 7: Effect of cutting type on number of shoots per cutting of pear cuttings cv. Patharnakh

Number of shoots per cutting					
	Cutting length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1 – Apical	1.33	2.00	3.33	3.00	2.41
T2 – Sub -apical	1.66	2.00	3.00	4.33	2.75
T3 – Basal	1.33	2.66	3.66	4.66	3.08
Mean	1.44	2.22	3.33	4.00	
		T	L	TL	
CD (p=0.05)	NS	NS	0.68		

Fresh weight of shoots (g)

Maximum fresh weight (7.94 g) was depicted by treatment L_4 while the minimum fresh weight (4.78) was recorded in L_1 cuttings. In case of cutting types, basal cuttings produced the heaviest shoots of 11.85 g and apical cuttings produced the shoots with lesser weight of 1.77 g. Interaction between the length and type of cuttings regarding fresh weight of shoots were found to be non-significant. This might be attributed to the fact that small cuttings are still under maturity and devoid of sufficient food material for induction of shoots. Long cuttings have sufficient reserved food and have more shoots resulting in higher fresh and dry weigh to shoots. Similar results are confirmed by Jana *et al.* (2015) in Asian pear. Singh and Singh (2016) in sweet orange cv. malta.

Table 8: Effect of cutting type and length on the fresh weight of shoots (g) of pear cuttings cv. Patharnakh

Fresh weight of shoots (g)					
	Cutting Length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1- Apical	0.56	0.88	1.50	4.13	1.77
T2- Sub – apical	4.31	6.50	6.73	6.91	6.11
T3- Basal	9.46	12.36	12.76	12.80	11.85
Mean	4.78	6.58	7.00	7.94	
		T	L	TL	
CD (p=0.05)	0.81	0.93	NS		

Dry weight of shoots (g)

The highest dry weight of shoots (5.66 g) was found in L_4 and the least (3.18 g) was in L_1. Among, type of cuttings maximum dry weight (9.12 g) was recorded in basal cuttings T_3 while minimum (0.75 g) was in T_1. This was in accordance with the number of shoots and fresh weight of shoots. Results are in conformity with Jana *et al.* (2015) in Asian pear. These results may be attributed to the fact that longer basal cuttings have high initial level of endogenous auxins and its oxidation enzymes IAA -oxidase which activate the shoot growth which might have resulted in the elongation of stems and leaves through cell division accounting for higher dry weight of shoots. The dry weight is also related with number of sprouts, diameter and length of sprout per cutting. The findings of Thota *et al.* (2012) in lemon cuttings and Kishorbhai (2014) in fig are in support with the present results.

Table 9: Effect of cutting type and length on the dry weight (g) of shoots of pear cuttings cv. Patharnakh

Dry weight of shoots (g)					
	Cutting length (cm)				
Cutting type	L1	L2	L3	L4	Mean
T1- Apical	0.21	0.38	0.57	1.83	0.75
T2- Sub apical	2.35	4.33	4.83	4.83	4.08
T3- basal	7.00	9.16	10.00	10.33	9.12
Mean	3.18	4.62	5.13	5.66	
		T	L	TL	
CD (p=0.05)	0.64	0.74	NS		

Number of leaves per cutting

It is evident from the results that the maximum number of leaves per plant (26.66) were observed from L_4 while the lowest (3.77) were recorded in L_1. On the other hand basal cuttings produced maximum leaves (18.50) and apical cuttings produced the lesser leaves to the tune of 11.83. Significant interactions between the length and type of cuttings were observed regarding number of leaves. Maximum leaves (32.00) were recorded in L_4T_3 while the minimum (3.00) was recorded in L_1T_1. The highest number of leaves were associated with number of sprouts as well as length of sprouts of cuttings, which in turn, was dependent on hydrolysis of reserve food materials, proper shoot and root balance. The research findings of Siddiqui and Hussain (2007) in Ficus and Al-Samaraee (2010) in cuttings of *Lawsonia inermis* L. are in line with the present findings.

Table 10: Effect of cutting type and length on number of leaves of pear cuttings cv. Patharnakh

	Number of leaves per cutting				
	Cutting length (cm)				
Cutting type	**L1**	**L2**	**L3**	**L4**	**Mean**
T1 –Apical	3.00	8.66	15.66	20.00	11.83
T2 - Sub apical	4.33	13.00	18.00	28.00	15.83
T3 - Basal	4.00	15.00	23.00	32.00	18.50
Mean	3.77	12.22	18.88	26.66	
		T	L	TL	
CD (p=0.05)		0.93	1.08	1.87	

Conclusion

The present study concluded that the macro propagation of pear cv. Patharnakh basal stem cuttings with length 50 cm was found to be the most efficacious in generating higher survival encouraging rooting parameters and invigorating the shoots leading to good shoot number, diameter, fresh and dry weight of shoots. It also aided to the good leaf production. Hence this study implies that the basal stem cuttings develop uniform plant stock for successful pear cultivation in one planting season.

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