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Reciprocal influences of rootstocks and scions on seedling vigor and survival in pear

JITENDER K CHAUHAN and UDAY SHARMA*

Directorate of Extension Education
***Krishi Vigyan Kendra, Chamba at Saru, HP**
Dr YS Parmar University of Horticulture and Forestry, Nauni 173230 Solan, HP
Email for correspondence: chauhanjkuhf@yahoo.com

ABSTRACT

The experiment was carried out to investigate the effects of rootstocks, scions and interstock on the growth performance and survival of pear seedlings using four rootstocks (Quince A, BA 29, Quince C and Kainth, *Pyrus pashia* Buck and Ham) and five commercial cultivars with and without interstock Beurre Hardy. The Red Brtlett scions grafted on Kainth without interstock gave maximum plant height, rootstock and scion diameter and leaf area. Maximum graft survival was in case of Flemish Beauty grafted on Kainth without interstock. The Beurre Hardy interstock was found to increase the compatibility of the scion cultivars with the clonal rootstocks as was evident by higher survival of these graft combinations with interstocks.

Keywords: Rootstock; scions; seedling; vigor; pear; Kainth

INTRODUCTION

Pear is an important fruit crop after apple among the temperate fruits and in Himachal Pradesh it occupies an area of 7,564 ha with a total fruit production of 23,990 MT (Anon 2005). Almost all pears grown commercially are propagated on seedling rootstocks. A high degree of congeniality or compatibility between the rootstock and scion cultivar is basic prerequisite for giving maximum length of economic life and juvenility to the grafted trees. Seedlings of Kainth (*Pyrus pashia* Buck and Ham) have been the main rootstocks for both European and Asian pears. The study of the interrelationships between scions, rootstocks and interstocks and their combined effect on the tree growth, fruiting and adaptability to adverse soil and climatic conditions is of great commercial utility.

MATERIAL AND METHODS

The experiment was conducted during 2004 and 2005 with a view to find the reciprocal influence of rootstocks and

scions on each other taking four rootstocks viz Quince A (RS_1), BA 29 (RS), Quince C (RS_3) and Kainth (*Pyrus pashia* Buck and Ham)(RS_4) grafted on five scions namely Flemish Beauty (S_1), Max Red Bartlett (S_2), Red Bartlett (S_4) and Starkrimson (S_5) with and without the use of interstock (Beurre Hardy) in all combinations randomized and quardately replicated. The interstock of 10 cm length was grafted at 7.5 cm height from ground level on one year old seedlings. The plant height was measured with the help of a measuring tape from ground level to the tip of the main axis whereas the rootstock diameter and scion diameter were measured with a digital vernier caliper at 5 cm above and below the grafted point. The number of nodes was counted on shoots above the graft union and average length of internodes was calculated by dividing total length of scion shoot by the number of nodes. For leaf area five leaves were collected from ten randomly marked plants and area compared using Li-Cor-3100 Leaf Area Meter. The root length and diameter were calculated by excavating ten marked plants. Light irrigation was given to carefully dig out complete root system which was washed with a jet of water to remove adhering soil. The length of main roots (>2 mm in diameter) was measured and diameter recorded with digital vernier caliper. The data on dry weight of shoots and roots were taken after cutting the marked plants from the point of transition of shoot and root and then dried in hot air oven at 65°C till constant weight. The two year data were pooled and subjected to statistical procedures given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The results exhibited in Table 1 reveal that the rootstocks and scions had a significant effect on the total plant height with maximum height of 1.10 m recorded for Kainth and 0.84 m for Red Bartlett when no interstock was used. With the introduction of interstocks the plant height increased except in case of Kainth rootstock but the increase was non-significant. In this case the Quince C gave a maximum plant height of 0.86 m. The interactions reveal that Red Bartlett grafted on Kainth without interstock gave the maximum height of 1.19 m. The increase in the plant height is according to the vigor potential of scions or rootstocks (Parry 1981, Ugolik and Kantorowicz 1993). The rootstock diameter was found to be the inherent character of the rootstock used and no reciprocal effect of scion cultivar was found however the rootstock diameter of 17.37 mm was noted in case of Kainth with interstock which was again in contrast to the results obtained for the clonal rootstocks used. On the contrary the scion diameter was found to be significantly affected by the rootstocks used and interstock introduction and their interaction. In Quince A the scion diameter increased with the interstock grafting whereas in other

Table 1. Effect of grafting combinations on plant growth, rootstock diameter and scion diameter of pear

Treatment	Plant height (m)					Rootstock diameter (mm)					Scion diameter (mm)				
	RS_1	RS_1	RS_1	RS_1	Mean	RS_1	RS_1	RS_1	RS_1	Mean	RS_1	RS_1	RS_1	RS_1	Mean
Without interstock															
S_1	0.68	0.69	0.81	1.04	0.81	10.26	11.31	9.47	16.30	11.84	4.91	5.54	5.73	7.84	6.01
S_2	0.71	0.64	0.77	1.10	0.81	9.24	11.48	8.64	17.19	11.64	6.52	6.33	6.88	6.72	6.61
S_3	0.62	0.62	0.76	1.05	0.76	9.22	10.47	6.89	17.83	11.10	4.71	6.28	6.72	7.55	6.32
S_4	0.68	0.69	0.79	1.19	0.84	9.34	9.18	8.53	16.43	10.87	4.40	6.88	6.85	8.03	6.54
S_5	0.66	0.71	0.82	1.10	0.82	10.50	11.31	9.65	17.09	12.14	4.45	6.44	7.03	7.91	6.46
Mean	**0.67**	**0.67**	**0.79**	**1.10**		**9.71**	**10.75**	**8.64**	**16.97**		**5.00**	**6.29**	**6.64**	**7.61**	
With interstock															
S_1	0.77	0.76	0.84	0.79	0.79	10.47	10.22	8.93	16.93	11.64	6.22	5.24	5.92	6.19	5.89
S_2	0.83	0.74	0.83	0.85	0.81	9.42	10.18	8.59	16.21	11.10	6.24	5.46	4.53	6.36	5.65
S_3	0.73	0.72	0.82	0.83	0.78	9.55	11.01	8.64	18.78	12.00	7.25	5.41	5.08	7.42	6.29
S_4	0.79	0.79	0.88	0.83	0.82	9.63	11.67	8.56	18.70	12.14	6.11	6.40	5.63	6.57	6.18
S_5	0.73	0.76	0.91	0.78	0.80	9.34	10.50	7.99	16.21	11.01	6.78	6.82	6.22	5.85	6.42
Mean	**0.77**	**0.75**	**0.86**	**0.82**		**9.68**	**10.72**	**8.54**	**17.37**		**6.52**	**5.87**	**5.48**	**6.48**	

$CD_{0.05}$		Plant height	Rootstock diameter	Scion diameter
	S	0.01	NS	NS
	RS	0.01	0.41	0.42
	I	NS	NS	0.19
	SxRxI	0.04	1.04	1.30

rootstocks it decreased. The maximum scion diameter (8.03 mm) was however recorded in Red Bartlett grafted on Kainth with interstock.

The data depicted in Table 2 show that the stock:scion ratio was also dependent on the rootstock properties and show an increase with the introduction of interstock except in case of Quince A. The number of nodes and the length of internodes were also found to vary and exhibited a reciprocal influence of rootstocks, scions and interstock. The introduction of interstock reduced the number and length. The maximum number of nodes (43.84) and intermodal length (2.47 cm) were reported in Red Bartlett on Kainth without interstocks which were significantly higher than all other combinations. The leaf area was significantly affected by the combined influence of rootstocks and scion cultivars (Table 3) and was found to decrease with the interstocks. The maximum leaf area of 19.53 cm^2 was for Kainth rootstock and that of 19.54 cm^2 for Conference scions and also their combination (22.24 cm^2) without interstock. The root length and diameter were found to be more affected by the nature of rootstock used. The maximum root lengths of 26.44 and 24.63 cm were for Kainth rootstock without and with interstock respectively and the combination of Starkrimson grafted on Kainth without interstock gave a maximum root length of 26.50 cm. The root diameter exhibited a similar trend with Kainth having a maximum diameter of 5.61 mm without interstock an 5.57 mm with interstock. The interactions show a maximum root diameter of 5.71 mm for Conference grafted on Kainth without interstock.

The results show that the rootstocks, scions and interstock and their interrelationships had a profound effect on the root mass with maximum value of 79.94 g for Kainth rootstock and that of 49.53 g for Red Bartlett scion. The introduction of interstock reduced the dry weight of roots. The interactions show that the maximum dry weight of roots (82.90 g) was for Starkrimson grafted on Kainth with Beurre Hardy interstock followed by Conference on Kainth without interstock (82.80 g). The dry weight of shoots was also influenced to a great extent on the properties of the rootstocks, scions and interstock. Quince C and Kainth rootstocks were found to have greater shoot biomass as compared to other rootstocks. The maximum dry weight of the shoot s was recorded in Red Bartlett grafted on Kainth without interstock (121.94 g) but the introduction of interstock was found to have a depressing effect on the shoot biomass. The data on the survival per cent shows that the traditionally used Kainth rootstock was superior over all other rootstocks when interstock was not used in all its combinations. The clonal rootstocks however behaved differently and the survival of plants was found to increase with the use of interstock however behaved differently and the survival of plants was found to increase with the use of interstock. Amongst the interstock introduced

Table 2. Effect of grafting combinations on stock/scion ratio, number and length of internodes of pear seedlings

Treatment	Stock/scion ratio (mm)					Number of nodes					Length of internodes (cm)				
	RS_1	RS_1	RS_1	RS_1	Mean	RS_1	RS_1	RS_1	RS_1	Mean	RS_1	RS_1	RS_1	RS_1	Mean
Without interstock															
S_1	2.12	2.05	1.65	2.32	2.04	22.33	23.67	26.83	36.05	27.22	2.10	2.11	2.22	2.30	2.18
S_2	1.44	1.87	1.28	2.58	1.79	25.34	24.17	28.00	40.84	29.59	2.11	2.15	2.21	2.33	2.20
S_3	1.99	1.77	1.04	2.39	1.80	24.67	23.67	26.50	37.67	28.13	2.16	2.18	2.19	2.32	2.21
S_4	2.15	1.38	1.26	2.09	1.72	24.50	26.67	30.67	43.84	31.42	2.15	2.20	2.35	2.47	2.29
S_5	2.38	1.93	1.38	2.16	1.96	22.67	24.17	29.17	37.67	28.42	2.12	2.19	2.22	2.30	2.21
Mean	**2.02**	**1.80**	**1.32**	**2.31**		**23.90**	**24.47**	**28.23**	**39.21**		**2.13**	**2.17**	**2.24**	**2.34**	
With interstock															
S_1	1.70	1.97	1.59	2.75	2.00	26.84	23.50	26.50	26.51	25.84	2.12	2.12	2.21	2.24	2.17
S_2	1.53	1.90	1.99	2.56	1.99	29.67	23.50	27.34	27.34	26.96	2.15	2.14	2.24	2.31	2.21
S_3	1.33	2.05	1.71	2.56	1.91	29.67	23.17	26.01	27.34	26.55	2.16	2.14	2.21	2.28	2.20
S_4	1.59	1.88	1.52	2.84	1.96	27.83	25.83	29.17	29.01	27.96	2.19	2.16	2.31	2.30	2.24
S_5	1.39	1.57	1.29	2.80	1.76	26.17	23.34	30.84	26.68	26.76	2.19	2.16	2.20	2.30	2.21
Mean	**1.51**	**1.87**	**1.62**	**2.70**		**28.04**	**23.87**	**27.97**	**27.38**		**2.16**	**2.14**	**2.23**	**2.29**	

$CD_{0.05}$	Stock/scion ratio	Number of nodes	Length of internodes (cm)
S	NS	0.79	0.02
RS	0.01	0.70	0.02
I	0.16	0.49	0.01
SxRxI	0.49	1.68	0.06

Table 3. Effect of grafting combinations on leaf area, root length and diameter of pear seedlings

Treatment	Leaf area (cm^2)					Root length (cm)					Root diameter (mm)				
	RS_1	RS_1	RS_1	RS_1	Mean	RS_1	RS_1	RS_1	RS_1	Mean	RS_1	RS_1	RS_1	RS_1	Mean
Without interstock															
S_1	13.29	15.38	13.92	17.45	15.01	18.42	14.03	10.92	26.35	17.43	3.48	2.52	.76	5.68	3.61
S_2	14.37	15.61	18.80	18.52	16.83	18.37	14.45	11.07	26.47	17.59	3.50	2.59	2.78	5.41	3.57
S_3	20.76	16.91	18.23	22.24	19.54	19.05	14.35	10.92	26.45	17.69	3.51	2.67	3.04	5.71	3.73
S_4	15.37	14.59	18.80	18.89	16.91	18.45	13.67	10.48	26.44	17.26	3.58	2.56	2.81	5.70	3.66
S_5	1439	16.772	1.29	20.56	18.25	18.82	14.07	10.65	26.50	17.51	3.55	2.50	2.87	5.53	3.61
Mean	**15.64**	**15.85**	**18.21**	**19.53**		**18.62**	**14.11**	**10.81**	**26.44**		**3.52**	**2.57**	**2.85**	**5.61**	
With interstock															
S_1	12.83	14.78	14.15	16.60	14.59	18.04	13.32	9.99	24.77	16.53	3.35	2.34	2.63	5.54	3.47
S_2	13.41	16.64	18.08	15.86	16.00	17.25	13.20	10.27	25.69	16.60	3.32	2.32	2.63	5.63	3.48
S_3	17.73	16.34	16.04	16.52	16.66	17.57	13.80	10.42	24.62	16.60	3.24	2.34	2.57	5.62	3.44
S_4	15.97	13.08	17.81	16.98	15.96	18.05	13.27	9.92	24.42	16.42	3.21	2.35	2.54	5.50	3.40
S_5	13.49	14.95	16.32	16.06	15.21	17.29	13.22	10.07	23.63	16.05	3.19	2.31	2.49	5.54	3.38
Mean	**14.69**	**15.16**	**16.48**	**16.40**		**17.64**	**13.36**	**10.13**	**24.63**		**3.26**	**2.33**	**2.57**	**5.57**	

$CD_{0.05}$		Leaf area	Root length	Root diameter
	S	1.06	NS	NS
	RS	1.13	0.25	0.06
	I	0.67	0.18	0.05
	SxRxI	1.86	0.79	0.08

Table 4. Effect of grafting combinations on dry weight of roots and shoots and survival of pear seedlings

Treatment	Dry wight of roots (g)					Dry weight of shoots (g)					Survival (%)				
	RS_1	RS_1	RS_1	RS_1	Mean	RS_1	RS_1	RS_1	RS_1	Mean	RS_1	RS_1	RS_1	RS_1	Mean
Without interstock															
S_1	39.74	33.11	29.74	74.72	44.33	78.35	88.50	105.87	114.54	96.82	50.9	53.3	53.3	93.3	62.7
S_2	37.74	34.09	30.24	82.17	46.06	78.80	90.00	107.12	115.89	97.95	35.5	3.3	42.2	86.7	49.4
S_3	44.77	37.11	31.61	82.80	49.07	79.30	90.27	10.59	119.22	98.60	51.1	48.9	53.3	80.0	58.3
S_4	46.11	39.15	31.90	80.97	49.53	78.69	89.07	109.85	121.94	99.89	37.8	40.0	46.7	86.7	52.8
S_5	45.21	40.24	25.43	79.02	47.48	76.54	90.27	105.56	119.82	98.05	40.0	51.1	51.1	77.8	55.0
Mean	**42.71**	**36.74**	**29.78**	**79.94**		**78.34**	**89.62**	**118.48**	**118.28**		**43.1**	**45.3**	**49.3**	**84.9**	
With interstock															
S_1	34.19	30.44	26.98	73.60	41.30	65.92	72.49	89.64	95.00	80.76	53.3	48.9	68.9	57.8	57.2
S_2	34.10	29.65	26.60	77.09	41.86	67.12	73.22	91.35	95.10	81.70	64.5	66.7	77.8	46.7	63.9
S_3	36.40	30.20	25.75	80.20	43.14	67.34	72.50	91.38	98.59	82.45	51.1	42.2	68.9	66.7	57.2
S_4	40.20	32.60	26.45	81.85	45.28	69.40	74.95	93.29	99.44	84.27	68.9	57.8	66.7	42.2	58.9
S_5	38.60	32.39	24.50	82.90	44.60	67.32	73.59	91.04	98.84	82.70	51.1	37.8	60.0	51.1	50.0
Mean	**36.70**	**31.06**	**26.06**	**79.13**		**67.42**	**73.35**	**91.34**	**97.39**		**57.8**	**50.7**	**68.5**	**52.9**	

$CD_{0.05}$	Dry wight of roots	Dry weight of shoots	Survival
S	2.07	1.11	0.48
RS	1.85	0.99	0.43
I	1.31	0.70	NS
SxRxI	NS	NS	1.37

combinations the maximum survival of 77.7 per cent was found in Max Red Bartlett grafted on Quince C rootstock thereby indicating that the compatibility of the rootstocks with the scion cultivars is of great importance and can be enhanced by the use of interstocks. The vigorous rootstocks show a higher biomass over the dwarfing clonal rootstocks in both stone as well as pome fruits. The results are in conformity of the findings of Stutte et al (1994) and Bianco (2003).

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