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Performance of Six Pear Cultivars on Clonal Old Home, Double Rooted, and Seedling Rootstocks[1]

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Abstract. **The pear cultivars 'Anjou,' 'Bartlett'. 'Bosc,' 'Comice,' 'Seckel' and 'Packham's Triumph' grown on 9 rootstocks were observed for tolerance to pear decline, tree size, bloom density, yield, fruit weight and leaf nutrient content. Cultivars on Old Home clonal rootstock or Old Home on nurse roots of Malling Quince A, Winter Nelis seedling or Bartlett seedling were smaller, had lower yield efficiency and greater uptake of Ca, Mg and Mn than when worked directly on Winter Nelis or Bartlett seedling rootstocks or *Pyrus calleryana* Decne. Winter Nelis and Bartlett seedling rootstocks were similar in performance but Winter Nelis seedlings had a lower yield efficiency than did Bartlett seedlings. Both had better uptake of Fe and Zn but were less precocious than *P. calleryana.* Fruit size was increased on *P. calleryana* and *P. betulaefolia* Bunge seedling rootstocks, particularly when topworked with 'Seckel'. Cultivars with Call rootstock had greater uptake of K than other rootstocks. A hybrid of *P. nivalis* Jacq. as a rootstock was inferior to other seedling rootstocks.**

Pear decline, a mycoplasma-induced disease, was introduced to Oregon in 1949 by pear psylla (*Psylla pyricola* Foerster). Pear rootstocks were found to influence the degree of phloem necrosis at the bud union caused by the pear decline mycoplasma (1, 2, 3, 5, 10). In the past the disorder has been referred to as "decline," "quick decline," "slow decline," or "pear decline." In this paper we will use "pear decline." Cordy (2) observed that double-worked trees in which Old Home interstocks had rooted were free of pear decline symptoms. Replacement trees were initially propagated on available rootstocks using scion-rooted or interstock Old Home for pear decline tolerance. Past rootstock evaluations in western states have concentrated mainly on resistance to diseases and soil conditions (5, 6, 8, 11) omitting tree growth and performance. In 1961, during the peak period of pear decline, a trial was established to evaluate the growth and performance of 6 cultivars on rootstocks deemed more tolerant of pear decline.

Materials and Methods

Nine rootstocks were planted on a 7.4 × 3.7 m spacing at the experiment station near Medford and field budded 5 cm high with 6 cultivars. Each cultivar block contained 8 replicates, 4 of which were 7.4 m from pollinizers, 3 at 15 m and 1 at 22 m away.

In 1961 the stock systems budded with the 6 cultivars were rooted Old Home (OH), deep planted OH interstock on Malling Quince A (OH/QA), OH on Winter Nelis seedlings (OH/NS), OH on Bartlett seedling (OH/BS), or single stocks of Winter Nelis seedling (NS), Bartlett seedling (BS), and *P. calleryana* seedlings (Call). In 1962 *P. nivalis* Jacq. × hybrid seedlings (Niv) were set and budded with the 6 cultivars, and 'Seckel' only was budded to *P. betulaefolia* Bunge seedlings (Bet).

Scion sources were: 'Anjou,' O.S.U. N.A. source, free of vein yellow virus; 'Bartlett,' Oregon Pear #9 (OP-9), free of vein yellows; 'Bosc,' Oregon Pear #5 (OP-5), free of stony pit virus; 'Comice,' from the East Malling Research Station, free of vein yellows; 'Packham's Triumph,' from Talent, Oregon; and 'Seckel,' from Del Rio Orchards, Gold Hill, Oregon.

The rootstock trial established on a Central Point sandy loam was irrigated every 14-20 days. A late fall application of urea was broadcast at 224 kg/ha annually. Sprays to control psylla and other pests were not initiated until 1967 to assure inoculation with the pear decline mycoplasma. Only light psylla infestation was noted during this period.

Performance of each cultivar on 8 or 9 rootstocks was evaluated for pear decline susceptibility, tree size, bloom density, yield, fruit size, and nutrient uptake. Extent of pear decline was rated on a scale from 1 (very vigorous) to 5 (no growth or crop), (Northwest ratings). It is recognized that factors other than pear decline may affect vigor. Tree size was based on cross-sectional area calculated from trunk diam above the bud union (9). Bloom density based on percentage of tree with bloom was obtained during the first 5 years to estimate precocity. Yield was obtained and accumulated for each tree for the first 10 years to indicate cropping. Fruit wt in 1971 was analyzed because of the full crop. Random sampling of 20 fruit from each tree was converted to g/fruit. Leaves from the mid-section of terminal shoots were sampled, washed and dried in August, 1971 and analyzed by direct-reading emission spectrometer for K, Ca, Mg, Mn, Fe, B and Zn. N was determined using a Technicon auto-analyzer. Rootstock data for 5

Table 1. Pear decline of 6 pear cultivars as influenced by rootstock (1969-70).

Stock system	Avg pear decline rating[z]						
	Anjou	Bartlett	Bosc	Comice	Packham's Triumph	Seckel	Avg[x]
OH	1.9ab[y]	1.9	1.9a	2.7	1.5	2.1	1.9
OH/QA	2.2a	2.2	1.9a	2.6	1.9	2.2	2.1
OH/NS	1.7ab	1.9	1.9a	2.6	1.7	2.0	1.8
OH/BS	1.4b	2.0	1.6ab	2.7	1.9	2.0	1.8
NS	1.5ab	1.9	1.7ab	1.6	1.7	2.1	1.8
BS	1.3b	1.9	1.4b	1.7	2.0	2.3	1.8
Call	2.0ab	1.9	1.6ab	1.5	1.2	2.3	1.8
Niv	1.4b	2.5	2.0a	1.8	1.6	1.9	1.9
Bet	–	–	–	–	–	1.9	1.9

[z]Northwest ratings for pear decline based on terminal growth: 1 = greater than 40 cm, 2 = 20-40 cm, 3 = 5-20 cm, 4 = 1-5 cm and 5 = less than 1 cm.

[y]Mean separation, within columns, by Duncan's multiple range test at 5% level.

[x]Avg excludes 'Comice' because of incomplete data.

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Table 2. Trunk cross-sectional area of 10-year-old pear trees as influenced by rootstock (1971).

Stock system	Avg trunk x-sectional area (cm^2)						
	Anjou	Bartlett	Bosc	Comice	Packham's Triumph	Seckel	Stock avg[y]
OH	169a[z]	130a	115cd	166a	140bc	150ab	141bc
OH/QA	118b	96bc	125bcd	125a	113cd	141b	118d
OH/NS	169a	118ab	151ab	138	166ab	186a	158a
OH/BS	212a	128a	159ab	126	149ab	157ab	161a
NS	194a	121ab	172a	176	158ab	159ab	161a
BS	188a	122ab	176a	167	132bcd	150ab	151ab
Call	168a	131a	182a	203	182a	135b	160a
Niv	106b	85c	104d	126	98d	92c	98e
Bet	–	–	–	–	–	92c	–

[z]Mean separation, within columns, by Duncan's multiple range test, 5% level.

[y]Avg excludes 'Comice' because of incomplete data.

Table 4. Yield of 6 pear cvs as influenced by rootstock (1965-72).

Stock system	Avg accumulated yield (kg) per tree						
	Anjou	Bartlett	Bosc	Comice	Packham's Triumph	Seckel	Stock avg[y]
OH	48de[z]	112c	30c	4	152b	76d	81c
OH/QA	20e	64d	32c	36	104d	76d	59c
OH/NS	96cd	132bc	84b	16	220ab	180b	143b
OH/BS	136bc	148abc	82b	36	192ab	160c	146b
NS	184ab	144abc	160a	8	264a	176bc	185a
BS	224a	188ab	172a	4	216ab	204a	198a
Call	192ab	212a	152a	80	256a	160c	194a
Niv	48de	72d	60bc	16	128cd	84d	77c
Bet	–	–	–	–	–	72d	–

[z]Mean separation, within columns, by Duncan's multiple range test, 5% level.

[y]Avg excludes 'Comice' because of incomplete plot.

cultivars and for rootstock-cultivar interactions were analyzed for significant differences at 5% level by Duncan's multiple range test.

Results

Pear decline susceptibility of cultivars on seedling rootstocks was rated as low or lower than those of OH rootstock (Table 1). Of seedling rootstocks, BS was the lowest with 'Anjou' and 'Bosc'; Call was least with 'Comice' and 'Packham's Triumph' and Niv and Bet were least with 'Seckel.' Smallest tree size, as measured by trunk cross-sectional area was noted on OH/QA (Table 2). Since rooting of OH interstock required 3 years, QA had a dwarfing effect before OH rooted. Trees of most cultivars, except 'Seckel' which are 1 year younger, were largest on Call root.

Influence of understocks on bloom density (Table 3) was reflected in accumulated yield (Table 4). OH understock reduced bloom density and yield compared with seedling rootstocks; most notable was OH/QA which had significantly lower yields on 5 cvs. Bloom density and yield were highest for 'Bartlett' and 'Packham's Triumph' on Call. Yield efficiency of 5 cultivars was significantly highest on Call in the 5th year, but highest on BS and Call in the 10th year (Table 5). The seedling rootstocks, NS, BS and Call had highest yield efficiencies at both the 5th and 10th year which were significantly greater than trees on OH rootstock. Low yield of trees on Niv stock was due both to younger trees and to lower yield efficiency.

Fruit wt (Table 6) was inversely related to cultivar yield on most rootstocks. Exception was noted with OH/QA where fruit wt and yield were low while on Call both fruit wt and yield were high. Rootstocks of OH produced cultivars having small fruit and yields that were generally lower than those of cultivars on seedling rootstocks. Both Bet and Call produced the largest fruit with the small-fruited 'Seckel'.

The OH rootstock increased uptake of Ca, Mg and Mn (Table 7). Cultivars on the OH/BS combinations had medium levels of Ca, Mg and Mn as compared with those on OH and BS alone. Woodbridge (11) did not observe higher levels of Ca and Mg due to OH rootstock. Seedling rootstocks had greater content of K and B than OH, but Call showed the greatest uptake. Trees on Call were lowest in Mn, Fe and Zn content which agreed with Woodbridge's observation (11).

Analysis of the cultivar replicates on yield and fruit wt did not indicate a significant influence by pollinizer distance except fruit wt of 'Bartlett' and 'Packham's Triumph.' 'Bartlett' fruit was largest on trees adjacent to 'Anjou' while the largest 'Packham's Triumph' fruit occurred on trees adjacent to 'Bosc.' The replicates more than 2 trees distant (14.8 m) from pollinizers had greater yields of 'Bartlett' and 'Packham's Triumph' while those closer to pollinizers were greater on 'Anjou,' 'Bosc' and 'Seckel.' Proximity of pollinizer increased fruit size of 'Bartlett,' 'Packham's Triumph' and 'Anjou' but not 'Bosc' and 'Seckel.'

Minimum temp of –22°C in Dec., 1972 injured tree trunks by splitting the bark above the bud union on the southwest

Table 3. Bloom density of 6 pear cvs as influenced by rootstock (1963-67).

Stock system	Avg % bloom density[z] for first 5 years						
	Anjou	Bartlett	Bosc	Comice	Packham's Triumph	Seckel	Stock avg[x]
OH	55ab[y]	59bc	58b	60	72b	59ab	60.6b
OH/QA	56ab	68b	56b	51	71b	48b	59.8b
OH/NS	63ab	53c	65ab	60	74ab	65a	64.0b
OH/BS	53b	67b	59b	60	71b	66a	64.1b
NS	70a	66bc	67ab	61	79ab	74a	71.1a
BS	54b	58bc	71ab	70	76ab	62ab	64.1b
Call	58ab	85a	66ab	61	85a	69a	72.6a
Niv	64ab	68b	79a	61	57c	75a	62.1b

[z]Bloom density was an estimate of % bloom covering bearing surface of the tree.

[y]Mean separation, within columns, by Duncan's multiple range test, 5% level.

[x]Avg excludes 'Comice' because of incomplete data.

Table 5. Pear yield efficiency and winter injury of 5 pear cvs as influenced by rootstock.

Stock system	Yield/trunk cross-sectional area (kg/cm^2 x 100)		Winter injury to trunk (% trees)
	1966	1971	1972
OH	4.1c[z]	27.3d	35
OH/QA	4.2c	24.8d	35
OH/NS	4.0c	39.4bc	30
OH/BS	3.9c	40.7bc	30
NS	8.9b	45.9ab	25
BS	11.2b	52.4a	38
Call	15.3a	49.2a	15
Niv	2.6c	36.8c	33

[z]Mean separation, within columns, by Duncan's multiple range test, 5% level.

[y]% of trees showing trunk splitting following the freeze of Dec. 1972.

Table 6. Fruit wt of 6 pear cvs as influenced by rootstock (1971).

Stock system	Avg fruit wt (g)						Stock Avg[y]
	Anjou	Bartlett	Bosc	Comice	Packham's Triumph	Seckel	
OH	157d[z]	134	183d	264	196	77bc	149d
OH/QA	155d	124	190d	178	190	72cd	147d
OH/NS	168d	134	199cd	154	212	70cd	157bc
OH/BS	157d	129	194d	207	198	73cd	150cd
NS	164cd	124	205bc	222	188	69cd	150cd
BS	162cd	127	207bc	189	192	63d	150cd
Call	183a	132	242a	295	196	86ab	168a
Niv	169b	134	217b	277	192	77bc	150b
Bet	–	–	–	–	–	91a	–

[z]Mean separation, within columns, by Duncan's multiple range test, 5% level.

[y]Avg excludes 'Comice' because of incomplete data.

Table 7. Mineral content of leaves of 4 pear cvs as influenced by rootstock (1971).

Stock system	N (%)	K (%)	Ca (%)	Mg (%)	Mn (ppm)	Fe (ppm)	B (ppm)	Zn (ppm)
OH	2.13	1.20b[y]	1.68a	.44a	145a	147ab	52b	36ab
OH/BS[z]	2.18	1.26	1.60	.44	134	174	54	38
NS	2.10	1.28ab	1.40c	.36b	94b	137ab	56b	38a
BS	2.07	1.33ab	1.42c	.35b	82b	152a	56b	33b
Call	2.11	1.42a	1.54b	.34b	59c	122b	62a	28c
Niv[z]	2.26	1.33	1.32	.35	91	133	53	37
Bet[z]	2.27	1.29	1.54	.31	65	159	51	32

[z]Data not included in statistical analysis due to incomplete data.

[y]Mean separation, within columns, by Duncan's multiple range test, 5% level.

side. No significant effect of rootstocks on bark injury was observed (Table 5). Though less injury occurred on Call, the main effect was by cultivar where 'Comice' trunks had none, 'Bosc' 12%, 'Packham's Triumph' 14%, 'Anjou' 31%, 'Seckel' 38% and 'Bartlett' 55%.

Discussion

This study indicated while OH appeared to be tolerant to pear decline (2, 6), tree vigor was not significantly greater than with *P. communis* and *P. calleryana* seedling rootstocks considered less tolerant. OH reduced early bearing compared with seedling stocks. Increased Ca uptake by OH rootstock should reduce "cork spot" incidence with 'Anjou'.

OH/BS and OH/NS protected against pear decline less than expected. OH was used as a second root in case the seedling was susceptible to pear decline, but most trees on seedlings showed no severe symptoms of pear decline after 10 years. Combinations of OH/BS and OH/NS performed better than OH clonal or OH/QA, but reduced yield efficiency compared with BS and NS. Because of the disadvantages of double working, such as susceptibility of the OH trunk to *Pseudomonas syringae* Van Hall, root sprouting, and reduction of yield and fruit wt, OH should be limited to solution of specific problems such as poor Ca uptake.

The NS and BS rootstocks were similar in performance, but NS trees cropped less than BS trees. These 2 rootstocks could be considered for high yielding cultivars such as 'Bosc,' 'Packham's Triumph' and possibly 'Bartlett.' Both NS and BS had better uptake of Fe and Zn than Call and might, therefore, be used on calcareous soils.

P. calleryana which induces early bearing should be used particularly with late cropping cultivars such as 'Anjou' and 'Comice,' as well as for small-fruited cultivars such as 'Seckel' to increase fruit size. This influence on fruit size is not fully understood, particularly since its yield efficiency is high. Greater uptake of K could be a factor (4). "Blossom blast" of pear bloom due to low B could be improved by Call because of greater efficiency of B uptake.

P. betulaefolia rootstocks which are more tolerant to pear decline than other seedling stocks (6) produced larger trees (6, 8), but had lower yield efficiency (8). High cropping cultivars with fruit sizing difficulty might be advantageously propagated on Bet, particularly when greater tree vigor is required, as with 'Bartlett' and 'Seckel.' The poor growth and performance noted on *P. nivalis* hybrids indicates this rootstock has no cultural advantage.

This study has shown that no single rootstock can be recommended for all situations, but each limiting condition should be considered before choosing a rootstock.

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