an infiltration solution of 4.5 μM ^{3}H-pyrazon. This compared with percentage conversions in the previous experiment of 68% and 44% for lines W223 and W285, where a 9.0 μM solution of ^{3}H-pyrazon was employed. In the nutrient culture experiment, there was a greater inhibition of growth for W285 than for W223 at both concentrations of pyrazon (Fig. 2). Clearly, of the 2 lines examined, W223, the line which most readily metabolized pyrazon, was also the most tolerant to this herbicide.

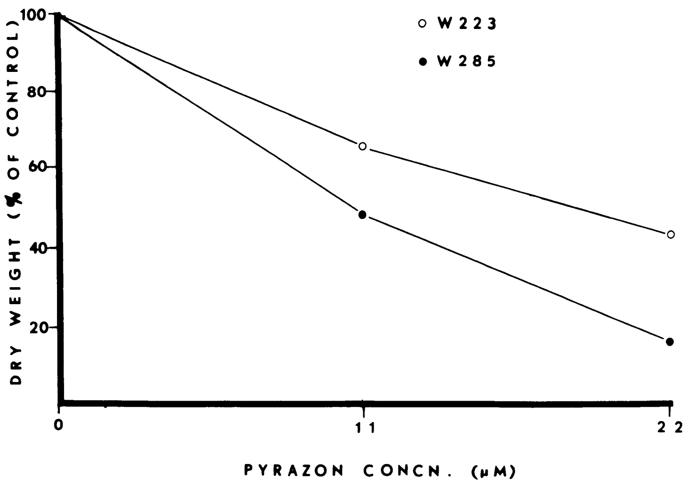

Fig. 2. Dry wt (% of control) of 2 inbred lines of red beet treated for 10 days with pyrazon in sand culture. Red beet line W285 produced less dry matter than W223 when treated with either 11 or 22 μM pyrazon (p 0.05).

These results support the hypothesis that the conversion of pyrazon to N-glucosyl pyrazon in tolerant species such as red beet, is the mechanism for detoxicification. The attachment of glucose may result in a nontoxic molecule or it may facilitate the removal of the pyrazon from the site of action. It is also apparent from this study, that inbred lines of red beets differ in their rate of pyrazon metabolism. Furthermore, a direct relationship existed between the rate of pyrazon metabolism and tolerance in the 2 lines of beet grown in sand culture. This genetic variability among different lines of beets may be useful in the development of red beet cultivars highly tolerant to pyrazon and other herbicides which are chemically similar.

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Effects of Trunk and Rootstock on Decline, Growth and Performance of Pear[1]

M. N. Westwood,[2] H. R. Cameron, [3] P. B. Lombard, [2] and C. B. Cordy[4]

Oregon State University, Corvallis

Abstract. Pear plots established in 1923 and 1926 with trees composed of several rootstock and trunk combinations were assessed for tree size, susceptibility to pear decline and for fruit quality. In general, *Pyrus ussuriensis* Max. and *P. pyrifolia* Burm. & Nak. rootstocks resulted in small trees, *P. communis* L. and *P. calleryana* Decne. intermediate, and *P. betulaefolia* Bunge large. The latter was most resistant to decline, followed by *P. calleryana* and *P. communis,* with *P. pyrifolia* and *P. ussuriensis* susceptible. The use of the oriental hybrid cvs. Variolosa and Tolstoy as interstocks increased the severity of pear decline symptoms though all trees were not uniformly susceptible. The use of the *P. communis* cv. Old Home as a scion rooted trunkstock decreased the degree of decline. Fruit quality was good on most combinations but was generally better on *P. calleryana* than other rootstocks. *Pyrus betulaefolia* caused cork spot and poor quality of 'Anjou' but this same rootstock resulted in outstanding quality of 'Seckel'.

Two pear plots were established near Medford, Oregon by F. C. Reimer for the purpose of studying fireblight resistance and general performance of 'Seckel' and 'Anjou' on various root-trunkstock combinations. Plot 1 (Ozark Orchard) was planted in 1923 and Plot 2 (Vilas Road) in 1926. There was no apparent graft incompatibility in any of the combinations, and prior to the occurrence of pear decline the trees were uniformly healthy, and had been so for many years.

The pear decline causal agent apparently was introduced into Oregon by psyllids from Washington in 1957 or 1958. With the knowledge that some rootstocks were tolerant or resistant to the disease[5] (1, 3, 4, 7, 9) existing pear rootstock plots were studied to learn as much as possible about the reaction of different rootstocks to the disease. Since these mature trees were healthy prior to 1958, we assume that visual decline or death after that time was due to the causal agent of pear decline. Both plots received good care both before and after 1958 when decline was found in Oregon.

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[2]Department of Horticulture.

[3]Department of Botany and Plant Pathology.

[4]Extension Agent, retired, Medford.

[5]C. B. Cordy. 1961. The effects of kind of rootstock and kind, length and location of interstock on pear tree performance and fruit quality. Ph.D. thesis. University of Florida. 81pp.

[6]Recent evidence (*Phytopathology* 60:499-501) indicates that possibly pear decline is caused by a mycoplasma rather than a virus.

Materials and Methods

Plot 2 near Medford was established in 1926 and included 6 different trunk/rootstock combinations, all top worked with 'Anjou' scions. Each combination was planted in a single row 21 trees long. Additional rows of trees of *P. communis* and *P. calleryana* roots were planted. The soil is clayey with relatively poor drainage.

Plot 1 south of Medford was planted in 1923. It included 25 rows 13 trees long. Each row consisted of 5 trees of 'Anjou' and 8 trees of 'Seckel'. Trunk/rootstocks of 21 combinations were planted in single rows, with 2 or 3 rows of 3 of the combinations. The plot has relatively shallow clayey top soil underlain with a lime layer. A low wet area runs diagonally across the plot. Except for fruit quality data, 'Anjou' and 'Seckel' were averaged to obtain tree growth and incidence of decline.

Fruit quality was evaluated after 3 to 4 months' storage at 30°F and 10 days ripening at 66-68°F. Quality ratings on a 0 to 15 scale included ripening uniformity, internal condition, and fresh eating quality. Ratings from 10 to 15 were considered good to excellent and those above 5 were considered acceptable.

These plots have been studied since 1958 to establish the influence of trunk and root on pear decline and general tree performance. Although the plots were not designed to randomize treatments, statistical analysis was done to present an estimate of the variability of the data.

Table 1. Effect of rootstock and trunk type on tree growth and yield of 'Anjou' pear (1962-66, plot 2).

Trunk/rootstock[a]	No. of trees	Avg/annu. yield[b] per tree	Quality rating	Trunk cross-section
		boxes		cm^2
Old Home/communis	21	12.5	7.4	1628
Anjou/communis	31	9.8	8 7	900
Old Home/betulaefolia	21	13.7	10.1	2088
Old Home/ussuriensis	21	9.5	9.3	1284
Old Home/calleryana	52	11.2	8.5	1477
Farmingdale/calleryana	21	10.9	8.8	1387
L.S.D. (.05 level)		2.3	NS	262

[a]All trees topworked with 'Anjou'.
[b]46 lb. per box, net.

Table 2. Effect of rootstock and trunk type on extent of pear decline of 'Anjou' pear (1963-66, plot 2).

Trunk/rootstock	Decline rating:[a] 1	2	3	4 & 5
		Percent of total no.		
Old Home/communis	81	10	5	4
Anjou/communis	38	25	10	24
Old Home/betulaefolia	93	5	0	2
Old Home/ussuriensis	48	36	12	5
Old Home/calleryana	58	34	4	3
Farmingdale/calleryana	42	36	8	14

[a]Northwest decline ratings: 1 = healthy
5 = very weak or dead

Results

Effects of rootstock and trunk type on yield, quality and tree size are shown for Plot 2 (Table 1). Yield per tree was numerically highest with *P. betulaefolia* root and lowest with *P. ussuriensis.* In general, differences in yield between rootstocks was small. Fruit quality did not differ greatly from stock to stock in this plot. Trees on *P. betulaefolia* roots were largest while those on low-budded *P. communis* were smallest. The presence of 'Old Home' trunkstock on *P. communis* improved yield and tree growth considerably relative to trees on *P. communis* without 'Old Home' trunks. It should be noted that the trees in this plot were examined for the presence of 'Old Home' rooting, and it was found that most of the trees possessing that trunkstock had rooted above the union. Thus these trees are double rooted to varying degrees. The trees of 'Anjou' directly budded to *P. communis* and 'Farmingdale'/*P. calleryana*, however, have only a single root system because 'Anjou' and 'Farmingdale' did not scion root.

It was previously shown (3, 8) that rooted 'Old Home' trunks tend to prevent pear decline and that trees worked directly on self-rooted 'Old Home' stocks were immune. This explains the better growth and yield and the lower incidence of decline when 'Old Home' trunkstock is used with *P. communis* (Table 2). Decline here is considered to be infectious pear decline and not cultural decline, because the trees were in good health prior to 1958, when pear decline was introduced. Double rooted 'Old Home'/*P. calleryana* had only slightly less decline than did 'Farmingdale'/*P. calleryana,* indicating the general resistance of *P. calleryana* root to decline. Trees on roots of the decline susceptible species *P. ussuriensis* (1, 10) showed less decline than expected, probably because of self-rooting of 'Old Home' trunkstocks.

In Plot 1 (45-year-old trees) initial survival of the original trees was generally 70% or better (Table 3). Survival prior to the advent of pear decline in 1958 was somewhat lower with some trunkstocks on *P. communis, P. calleryana* and *P. ussuriensis*

Table 3. Effect of rootstock and trunk type on tree survival, growth and fruit quality of 'Anjou' and 'Seckel' pear (1958-66, plot 1).

Trunk/rootstock	Trees planted	Trees alive 1958	Trunk area: 1958	1966	8-yr. increase	1961-62 Fruit quality ratings Anjou	Seckel
	No.	*%*	cm^2	cm^2	cm^2		
Old Home/ussuriensis	39	95	616	802	186	8.4	10.4
Old Home/calleryana	26	88	840	1156	316	9.7	10.3
Old Home/communis	26	88	795	976	181	10.4	9.4
Old Home/betulaefolia	13	92	1284	1698	414	4.6	11.1
Old Home/serotina	13	92	673	912	239	8.4	9.8
Variolosa/ussuriensis	13	100	1046	1223	177	8.6	6.6
Variolosa/calleryana	13	100	1042	1284	242	10.8	10.7
Variolosa/communis	13	85	843	1048	205	10.3	10.3
Variolosa/betulaefolia	13	85	1073	1393	320	8.8	11.6
Variolosa/pyrifolia	13	69	835	1076	241	8.6	--
Tolstoy/ussuriensis	13	77	543	609	66	8.4	9.0
Tolstoy/calleryana	13	77	733	922	189	11.1	10.5
Tolstoy/communis	13	77	656	832	176	9.6	10.4
Farmingdale/ussuriensis	13	85	949	1146	197	--	--
Longworth/ussuriensis	13	54	388	430	42	--	--
Hung Guar Li/ussuriensis	13	85	361	422	61	10.2	9.4
B.R. pyrifolia/calleryana	13	38	615	783	168	7.0	--
Calleryana/calleryana	13	69	741	973	232	10.1	11.4
Variety/calleryana	13	46	721	914	193	11.2	--
Hung Guar Li/calleryana	13	77	576	696	120	--	10.8
Nelis/communis	13	54	559	746	187	9.4	10.1
L.S.D. (.05 level)			242	--	109	3.8	2.6

rootstocks than with others. The reason for this is unknown, but it was not due to pear decline, since the mortality occurred before decline came into Oregon. Trees on *P. betulaefolia* root were again the largest. Their growth was also better during the first 8 years after pear decline entered the area in 1957-58. This supports previous reports (7, 8) that *P. betulaefolia* is the most decline resistant of all seedling rootstocks. Comparisons of trunk growth must be confined to groups with a common trunk type because different genetic types grow at different rates. Fruit quality was similar among the several trunk/rootstock combinations, with a few notable exceptions. 'Anjou' on 'Old Home'/*P. betulaefolia* had poor quality because of cork spot. This disorder was previously reported for 'Anjou' on *P. betulaefolia* (3). 'Seckel' quality was low on 'Variolosa'/*P. ussuriensis* but was generally good on all other combinations. In contrast to 'Anjou', 'Seckel' quality was outstanding on *P. betulaefolia* rootstock. Quality of both cultivars was usually better on *P. calleryana* root than most others, regardless of interstock.

'Old Home' interstock produced a higher percentage of healthy trees after 1958 than did the others (Table 4). This came as a result of partial self rooting of 'Old Home'. There is no evidence that non-rooted 'Old Home' interstocks have any influence on decline. Interstocks of the oriental hybrids 'Tolstoy' and 'Variolosa', however, resulted in increased decline. However, as seen in Table 4, some trees of every combination involving 'Variolosa' interstock are vigorous and healthy. Tree losses from decline were greatest with *P. ussuriensis* and *P. serotina* and least with *P. betulaefolia* rootstocks. Tree size and recent growth were greatest with *P. betulaefolia* root and smallest with *P. ussuriensis.*

Table 4. Effect of root and trunk type on tree decline and growth of 'Anjou' and 'Seckel' pear (1958-66, plot 1).

Trunk/rootstock[a]	Pear decline stage: 1	2	3	4,5	Tree growth for 8 years (1958-1966)
		% of total number			*% of 1958*
Old Home/ussuriensis	0	41	32	27	30
Old Home/calleryana	36	45	9	9	38
Old Home/communis	35	48	13	4	23
Old Home/betulaefolia	91	9	0	0	32
Old Home/pyrifolia	33	42	17	8	36
Variolosa/ussuriensis	31	0	0	69	17
Variolosa/calleryana	31	23	23	23	23
Variolosa/communis	9	36	18	36	24
Variolosa/betulaefolia	55	18	9	18	30
Variolosa/pyrifolia	11	22	0	67	29
Tolstoy/ussuriensis		0	11	89	12
Tolstoy/calleryana	10	60	10	20	26
Tolstoy/communis	22	44	11	22	27
Farmingdale/ussuriensis	0	9	9	82	21
Longworth/ussuriensis	0	0	0	100	11
Hung Guar Li/ussuriensis	0	18	0	82	17
B.R. pyrifolia/calleryana	40	0	60	0	27
Calleryana #1/calleryana	56	22	11	11	31
Variety/calleryana	17	33	0	50	27
Hung Guarli/calleryana	10	40	30	20	21
Winter Nelis/communis	14	57	29	0	33
Variety/communis	23	50	23	5	32

[a]Variolosa = oriental hybrid clone
Tolstoy = Clapps x *P. ovoidea* clone
Longworth = blight resistant *P. communis* clone
Hung Guar Li = oriental hybrid clone probably *P. ussuriensis x P. serotina*

Discussion

Our studies and those of Griggs et al. (4) do not confirm the conclusion of Blodgett et al. (2) and Batjer and Schneider (1) that *P. calleryana* rootstock is susceptible to pear decline. They stated that both domestic and imported *P. communis* were more resistant to decline than *P. calleryana*, based upon apparent sieve-tube necrosis. The study of Blodgett et al. (2) reported positive phloem necrosis in bud union samples of *P. calleryana* rooted trees, but these trees remained vigorous and healthy. This casts some doubt on the validity of the test for some stocks. Both young (7) and old trees (8) on *P. calleryana* have out-yielded other stocks in Oregon tests and have been as resistant as *P. communis* although both show some pear decline. *Pyrus calleryana* has not been fully tested for cold hardiness. Also in another plot at Medford, *P. calleryana* worked 12 to 15 inches above ground produced weak trees. Either sunscald or high temperature injury is suspected, and is being studied.

Except where 'Old Home' interstock had self rooted, trees on *P. pyrifolia* and *P. ussuriensis* were highly susceptible to decline. Interstocks of cultivars having *P. ussuriensis* or *P. pyrofolia* parentage generally resulted in more decline than did those of *P. communis.*

Pyrus betulaefolia rootstocks were outstandingly more resistant to pear decline than any other seedling type. This result agrees with other published work (1, 7, 8). It also develops a much larger tree than other stocks, making it useful in poor soils or with weak growing cultivars. In other situations it can be too vigorous. 'Anjou', for example, is too vegetative on this stock. The relatively high leaf-fruit ratio predisposes the fruit to internal corking known as cork spot or drought spot. This condition resulted in the low quality of 'Anjou' fruit shown in Table 3. On the other hand, 'Seckel' on *P. betulaefolia* set heavy crops of good quality fruit.

Results with 'Variolosa' interstock are puzzling. Previous reports (5, 7) indicated that this clonal line of oriental hybrid is highly susceptible to pear decline. Tsao et al. stated: "According to Dr. W. H. Griggs (personal communication), 'Variolosa' trees on their own roots (developed from rooted cuttings) are highly susceptible to pear decline virus, and many such trees have died from the disease in the experimental orchards at Davis. Our study substantiates 'Variolosa's' susceptibility to the virus, and the distinct brown vein symptom which appears under greenhouse environment may be useful in the diagnosis of the disease."

According to the description of pear decline, (1, 5) phloem tissue of susceptible trees is killed by the causal agent[6], resulting in a reduction of food translocation to the root system, and frequently to death of the tree. When genetically identical trees (vegetatively propagated roots and scions) are inoculated the trees should be equally susceptible. The 'Variolosa' interstock used in the Oregon tests was the same clone as used in California (4, 6), and should have been uniformly susceptible. Yet up to 55% of the trees with 'Variolosa' interstocks (Table 4) are healthy and vigorous after more than 10 years' exposure to the agent causing pear decline. The extent of decline appears related to the rootstock rather than to the fact that the trees contained 'Variolosa' interstocks. Either 'Variolosa' is only slightly susceptible to pear decline, or the rootstock or scion affects the mode of action of the causal agent. The complex interaction between the causal agent and multigenetic grafted trees needs further study.

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Propagating Apples in Peru by an Improved Mound Layering Method[1]

Cesar Medina and Odilo Duarte
Universidad Nacional Agraria, LaMolina, Lima, Peru

Abstract. It was found possible to produce grafted apple plants (*Malus sylvestris* Mill.) on quince rootstock (*Cydonia oblonga* L.) in 1 year, by introducing an improvement to the classic mound layering method, this improvement was based on the grafting of the mound layered shoots while still attached to the mother plant using single or double grafting.

Spring is the normal season for starting the process, but satisfactory results were also obtained when starting in the fall. This study emphasizes the potential of this improved method in relation to the number of plants that can be obtained per area and the time that can be saved.

Mound layering is the most common method for propagating clonal apple rootstocks, like those of the Malling and Malling-Merton series and quinces (1, 4, 7); as well as for some plum rootstocks (3).

In the subtropical regions of America, especially in Peru, quince is a popular rootstock for apples (1), because of its dwarfing effect, its low chilling requirement, and its good behavior under poor soil conditions, and in the presence of the woolly aphid (*Eriosoma lanigerum* Haus). Although quince does not show good compatibility with most apple cultivars (4), this can be overcome by using an intermediate stock, like the 'Cara Sucia' apple in Argentina (1, 2) or the 'San Antonio' and 'Pero Manzano' apples in Peru.

There is information (5, 6), that with mound layering, it takes 1 to 2 years to produce the rootstock plus 1 additional year for the scion to grow. The same is true when using apple seeds (4, 7). Under our conditions at least 1 year is needed to get the rootstock from apple seeds or quince cuttings, plus 1 additional year for the scion to grow. Thus under optimum circumstances, at least 2 years are needed to obtain a grafted apple plant. Based on preliminary results for some climatic conditions like those of Lima, Peru, the method could offer advantages, such as: increasing the number of plants propagated, in a specified area, allowing for vegetative propagation of rootstocks and shortening the time needed to produce a plant.

Materials and Methods

The trials started in 1964 were continued 3 years at one of the University's plots. The soil had a loamy texture and a granular structure. The average climatic conditions during this time were characterized mean temperature 18.4°C; monthly mean maximum 22.3°C; monthly mean minimum 14.4°C; mean relative humidity 83.5%; monthly mean maximum 94.4%, monthly mean minimum 72.6%. The monthly average of hours of sun was 140 in summer and 33 in winter. The total absence of rain made furrow irrigation necessary throughout the year.

Classic mound layering in quince and direct grafting. Cut made in Spring. About 40 quince plants of the cultivar 'Blanco' planted 0.5m apart in 2 rows separated by 1.0m. They were 4 years old and had been through 1 mounding cycle the year before. The procedure described by Hartmann and Kester (4) was followed, starting the cycle with the cut of the stem or stems of the mother plants to a 3cm stump in October. Sprouting began 2 weeks later and the new shoots were mounded twice, 3 and 5 weeks after sprouting.

The mother plants were divided into 2 groups of about 20 each and 100 days after the cut, when proper size had been attained, the shoots of one group were cleft grafted with cold stored scions of the creole apple 'San Antonio', leaving the other group as a control.

The plants were harvested the following October for evaluation of dry weight, height from the base of the shoot to the tip or to that of the scion, and diameter at 30cm from the base in the nongrafted shoots and 5cm above the graft union in the grafted ones.

This trial was continued for 8 additional months, transplanting the harvested shoots 0.5m apart in rows separated 1.0m. To compare the direct grafted shoots and controls that were grafted by the normal method 3 months after transplanting. Eight months after transplanting, when growth had stopped (June 1966), the plants were harvested for final evaluation.

Direct grafting and double grafting. Cut made in Fall. To study the possibility of starting the cycle in fall, twenty quince mother plants that were 4 years old and had been through 2 mounding cycles were used. The cut was made in May and 180 days later, when proper size had been attained, the shoots of 10 plants were cleft grafted with fresh scions of 'Winter Banana' apple. The shoots of the other 10 plants were double grafted using splice grafts. 'San Antonio' and 'Pero Manzano' were used as intermediate stocks with 'SIPA C6' grafted on as the scion cultivar. All plants were harvested the following May for evaluation.

Results and Discussion

Classic mound layering in quince and direct grafting. Cut made in Spring. Growth of the shoots allowed us to graft them 100 days after starting the process. Grafted apple plants with 7.7mm diameter, 5 cm above the graft union, and a height of 97.7 cm were obtained after 1 year (Table 1). This can be considered satisfactory for taking the plants out to the orchard or for keeping them an additional year in the nursery to start their training.

Growth of the controls, that did not lose any foliage due to grafting, was significantly superior to that of direct grafted shoots at the time of harvest (Table 1). However, the controls were grafted 3 months after transplanting. This drastically

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