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Scion/Rootstock Influence on Tree Survival of Asian Pears in the First Growing Season[1,2]

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Abstract

Tree mortality in a new planting of 10 Asian pear cultivars ('20th Century', 'Chojuro', 'Hosui', 'Kikusui', 'Niitaka', 'Okusankichi', 'Seigyoku', 'Shinku', 'Shinseiki' and 'Tsu Li') on 5 Old Home x Farmingdale (OHF) rootstocks (OHF 51, OHF 97, OHF 217, OHF 282, OHF 333) and Provence quince rootstock was related to rootstock and scion which, in turn, appeared to be related to water stress. Mortality was 21% overall. Survival rate in relation to rootstock ranged from 57% for OHF 51 (most dwarfing) to 94% for OHF 217 (semi-vigorous). Survival in relation to scions ranged from 57% and 64% for 'Tsu Li' and 'Niitaka', respectively to 97% for '20th Century' The combinations exhibiting the poorest survival were 'Tsu Li' (9%) and 'Niitaka' (14%) on OHF 51.

Introduction

Asian pears, developed from *Pyrus ussuriensis* Maxim, *P. serotina* Rehder, and possibly *P. bretschneideri* Rehder (3), have been the object of detailed study in the Orient for well over 2000 years (5), but have only recently attracted much attention in the United States. Because of recent interest, a planting of 10 Asian pear cultivars on 5 OHF *(P. communis)* rootstocks and Provence quince *(Cydonia oblonga* Mill.) was set out in 1985 at Washington State University's Royal Slope Research Unit near Othello, Washington. The experiment's long-term goal was to evaluate rootstock influences and the relative productivity of the various scion/rootstock combinations. Differential mortality among the several scion/rootstock combinations was observed early in the first growing season and is reported in this paper.

Materials and Methods

One-year-old trees of uniform size of each scion/rootstock combination (Table 1) were planted 1 and 2 April 1985. Sample sizes varied because of unanticipated incompatibility with Provence quince in the nursery and lack of availability of 'Niitaka budwood.' To the extent possible, 3 trees of each scion/rootstock combination were planted in each of 4 replicate blocks. Spacing was 3.0 x 5.1 m with rows oriented north-south on a uniform south-facing slope. Sweet cherries had been grown on this site for the previous 20 years, but pear trees were not planted into positions previously occupied by cherries. Tree roots were protected prior to planting with plastic bags containing moist peat.

Initial irrigation of the trees was delayed for 7 days after planting because of an unexpected break in the water supply. Subsequent irrigation until 1 June was 55 mm every 10 days from overhead sprinklers. On 3 June the interval was shortened to 7 days and, on 8 July, the amount applied was increased to 110 mm at each irrigation. During the period 1 June to 15 July, precipitation was 7 mm, about 10 mm less than normal (6), and open-pan evaporation was 322 mm. Irrigation from 1 June to 15 July supplied 497 mm of water. Maximum temperatures averaged 27.5°C during this period although temperatures on some days exceeded 35°C. Average temperatures were approximately 5° above

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Table 1. The influence of rootstock (Provence quince and Old Home × Farmingdale) and Asian pear scion on tree survival in the first growing season.

	Number of trees	Observed survival (no.)	Observed survival (%)	Expected survival (no.)
Rootstock				
Prov. quince	36	33	92	29
OHF 51	128	73•	57	101
OHF 97	128	109	85	101
OHF 217	127	120•	95	101
OHF 282	132	97	74	105
OHF 333	141	116	82	112
Scion				
20th Century	66	64°	97	52
Chojuro	73	57	78	58
Hosui	66	51	77	52
Kikusui	66	55	83	52
Niitaka	44	28•	64	35
Okusankichi	72	51	71	57
Seigyoku	75	68°	91	59
Shinku	70	64°	91	55
Shinseiki	78	63	81	62
Tsu-Li	82	47•	57	65

•A significiant deviation from expectation on the basis of random mortality.
($P < 0.05$) using adjusted standardized residuals.

normal. Severe wilting and a general decline in tree condition were first noted on 24 June. Total mortality was recorded on 23 July. Trees that had died, in addition to those that would clearly not survive the remainder of the growing season, were all classified as dead. Trees that appeared normal or only somewhat impaired were included in the 'alive' category.

The mortality of scions and rootstocks were independently subjected to chi-square analysis with individual cells of the contingency tables analyzed using the adjusted standardized residuals (2). Low sample sizes precluded formal hypothesis-testing of the mortality of scion/rootstock combinations.

Results and Discussion

Of the 692 trees planted in the experiment, 144 (21%) died. The effect of rootstock on mortality was significant ($P = 0.0001$). Survival was best of trees on OHF 217 whereas survival of trees on OHF 51 was poorest (Table 1). Scion also significantly affected mortality ($P = 0.0001$). Survival of '20th Century', 'Shinku', and 'Seigyoku' scions ranged from 23 to 15% greater than expected while survival of 'Tsu Li' scions was significantly lower (Table 1).

Selected rootstocks and scions which exhibited differential mortality were examined in combination to assess the potential effect on mortality of a scion/rootstock interaction. This analysis (Table 2) indicated that substantial mortality occurred when rootstocks and scions of high individual mortality were combined.

Table 2. Expected (on the basis of random mortality) and observed frequencies of survival of selected Asian pear/Old Home × Farmingdale (OHF) scion/rootstocks combinations.

Rootstock	Scion	Number of trees	Observed survival (no.)	Observed survival (%)	Expected survival (no.)
OHF 51	Tsu-Li	12	1	8	10
OHF 51	Niitaka	7	1	14	6
OHF 51	Shinku	15	12	80	12
OHF 51	Seigyoku	12	9	75	10
OHF 51	20th Century	12	11	92	10
OHF 217	Tsu-Li	12	9	75	10
OHF 217	Niitaka	10	8	80	8
OHF 217	Shinku	10	10	100	8
OHF 217	Seigyoku	12	12	100	10
OHF 217	20th Century	12	12	100	10

However, the high mortality of OHF 51 rootstock was ameliorated by scions with higher survival frequency. Also, rootstocks with high survival frequency appeared to moderate the effects of a scion with high mortality. While an apparent disadvantage accrued from combining rootstock and scion both having low survival, no converse advantage resulted from combining rootstock and scion, each having high survival (Table 2).

The evidence suggests that drought was the main cause of the high (21%) mortality among these trees. Several factors support this conclusion. Soil moisture at planting time was low (visual observation), and initial irrigation was delayed. Weed control in June and July was poor, and evaporative demand was high during this period. When applied water was increased and weed competition was reduced, tree condition improved. It appears therefore that OHF 51 rootstock and 2 scions ('Tsu Li' and 'Niitaka') that exhibited high mortality may be more susceptible to drought, while OHF 217 rootstock and 3 scions ('20th Century', 'Seigyoku,' and 'Shinku'), having high survival frequency, were more drought tolerant.

The potential effects on mortality of a rootstock and scion interaction could not formally be tested, although an interaction is suggested (Table 2). Percentage survival was generally high regardless of scion as long as the rootstock survival was high; survival was lowest when susceptible scion and rootstock were budded together.

Unfortunately, a control moisture regime did not exist, and the correlation between the pears' productivity and their response to drought as new transplants is unknown. Furthermore, no data exist concerning the effects on mortality of scion/rootstock compatibility, or of the preplanting history of the stock. Delayed fruit production in 'Tsu Li' compared with other Asian pears (3) may be related to an apparent susceptibility to drought reported here, although Griggs and Iwakiri (3) indicated that delayed bearing may not be correlated with ultimate production. The OHF rootstock with the highest survival (OHF 217) may have a higher yield efficiency than more vigorous rootstocks (OHF 97), although its ultimate yield efficiency may be equivalent to that of OHF 51 (7).

Response of pear trees to drought depends on a number of factors including the severity of drought, plant age, and tree spacing (1, 4). This, coupled with the correlation between vigor and drought tolerance in *P. betulaefolia* (5, 8), leads to a very important question. In light of the wide variety of habitats available for pear production and the variability of characteristics among available scions and rootstocks, what is the relationship among rootstock, scion, vigor, yield efficiency, and drought tolerance?

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