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A Multi-site Pear-interstem Trial in the Netherlands and Belgium

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Abstract

An interstem trial was planted in the spring of 1989 with two pear cultivars 'Conference' and 'Doyenné du Comice' on the tender Quince MC rootstock with six interstem cultivars, *viz.* 'Beurré d'Anjou,' 'Beurré Hardy' (standard), 'Doyenné du Comice,' 'Nouveau Poiteau,' 'Old Home' and 'Flemish Beauty' to determine the influence of the interstems on winter hardiness and growth control. Two-year-old trees budded directly on Quince MC served as controls. The trees were planted at two sites in The Netherlands and one in Belgium in single rows at distances ranging from 3.00m x 1.30m to 3.50m x 1.50m and trained as slender spindles. The trial was evaluated until 1998.

No damaging freezes occurred during the experimental period, therefore no conclusions could be drawn with regard to the winter hardiness of the interstem cultivars involved. Vigor control was obtained with 'Beurré d'Anjou' and 'Flemish Beauty,' probably as a result of incompatibility of these two interstem cultivars with the Quince MC rootstock. The interstems compatible with the Quince MC rootstock did not provide vigor control, or promoted it, as was the case with 'Old Home.' The 'Old Home' interstem reduced cropping. 'Nouveau Poiteau' had a small negative effect on the fruit size of 'Conference.' 'Beurré Hardy' and 'Doyenné du Comice' are useful interstems for Conference, but do not reduce vigour. For 'Doyenné du Comice,' with the exception of the poorly compatible interstems, none of the other interstems studied reduced vigor.

Introduction

During early January in 1985, a sudden and severe winter freeze after months of mild weather, negatively impacted the Dutch pear industry. Both, Quince (*Cydonia oblonga* Mill.) rootstocks and scion cultivars were injured. The damage was more severe with the main cultivar 'Conference' than with 'Doyenné du Comice,' the cultivar that is second in importance. Quince MC rootstocks were more injured than Quince MA (12, 13). With apple, certain interstems saved trees from the damage inflicted by this freeze. One of these "Summerred," that imparted some winter hardiness, also appeared to moderate growth, which is a desirable characteristic (10). In pear, no real dwarfing rootstocks are available (14). Strong vigor has been controlled in Belgium and the Netherlands with the aid of the growth retardant chlormequat (CCC). Currently, this practice is being abandoned, because markets demand fruit with a low or no residue. Therefore, interest is increasing for non-chemical growth-controlling methods. Use of an interstem might be a way to control growth as it has been in apple. In pear, use of interstems has long been common for cultivars that are incompatible with Quince rootstocks. For this purpose 'Beurré Hardy' or 'Le Curé' have been or are being used in North-western Europe, but these do not provide growth control (3, 7, 8). In the past, reduction and promotion of growth by interstems has been observed (3, 8, 9). However, as the material used at that time was not virus free and because the presence of viruses in pear trees moderates growth (6, 16), old information is of little use for the current virus free material. Therefore, it was decided to establish a trial with virus free, hardy interstems to determine whether an interstem could be found that reduces growth. Upon recommendation by pomologists from areas where severe winters are common, interstems were collected from Canada ('Flemish Beauty,' 'Moe,' 'Old Home,' 'Ottawa 291,' 'Ure') and from Scandinavia ('Alebypäron,' 'Gråpäre' (= 'Beurré Gris'), 'Rörstrand,' 'Sörmlandspäron'). Although

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evaluated for some time in the trials, all these cultivars, except 'Flemish Beauty,' were discarded, because they were not virus free. Trees on these virus infected interstems grew irregular and weak and the leaves did not look healthy. 'Beurré Gris' was an exception, but because of its uncertain virus status, was also discarded. Upon advice from H. A. Quamme, 'Beurré d'Anjou' (BA) was included in the trial as well. This cultivar was obtained virus free from the Inspection Service for Arboriculture Produce (NAKB) in The Netherlands. As hardy standards, 'Beurré Hardy' (BH) and 'Doyenné du Comice' (DC) were included as well as 'Nouveau Poiteau' (NP). Field observations suggested this genotype may also produce growth-reducing effects. These three genotypes were obtained from Dutch virus free mother trees. Two other interstems were included in the trial; 'Flemish Beauty' (FB) and 'Old Home' (OH).

Material and Methods

In March 1986, uniform virus-free rooted layers of Quince MC rootstock were bench-grafted with the six pear cultivars mentioned above and planted out in a nursery block with the union 10 cm above ground level. In August 1987, one year later than intended because of slow development, interstem shoots were budded with virus-free 'Conference' and 'Doyenné du Comice' at about 30 cm above the rootstock-interstem union. The one-year old scions were planted in the spring of 1989 at three sites. As controls, 2-yr-old trees were planted at the same time. The controls were grown in the same nursery, from bench-grafts made in the spring of 1987 of the two scion cultivars directly onto Quince MC rootstock. Thus, the root systems of the control and interstem trees were of the same age. The trees were planted at the national fruit research stations in Wilhelminadorp, the Netherlands and Velm, Belgium, and in the Dutch regional experimental garden at Zeewolde. The loess soils at Velm and the young sea clay soil at Zeewolde induce good vigor, while that at Wilhelminadorp (a 50 cm sea clay layer on fine sand) induces moderate vigor. The number of replicates varied per site from 4 to 8 with 2 to 3 trees per plot. Treatment FB was missing for 'Doyenné du Comice' at Velm and Zeewolde. The trees were planted in single rows at distances of 3.00 m x 1.30 m (Zeewolde), 3.50 m x 1.40 m (Wilhelminadorp) and 3.50 m x 1.50 m (Velm). The alleys between the tree rows were maintained in sod and the tree strips were kept weed free through the use of herbicides. Trees were trained as spindles, not irrigated and managed according to local practices. No (Wilhelminadorp) or little (Velm, Zeewolde) fruit thinning was done during the years of the experiment. The trial lasted until the winter of 1998/99.

At planting, after the fourth growing season (not at Zeewolde) and at the end of the trial the trunk circumference of the scion cultivar was measured at 10 cm (Dutch trials) or 25 cm (Velm) above the union with the interstem. At planting of the Zeewolde location, shoots per tree were counted and their length were measured. After the fourth growing season and at the end of the trial, tree volume was determined. Tree volume was calculated from the average tree crown diameter and height using the formula for the volume of a cone ($1/3(\pi r^2 h)$). Tree diameter was measured in two perpendicular directions, each at 45° with the tree row, at the base of the crown up to the extremities of the 2-yr-old wood. Tree height was measured from the insertion of the lowest scaffold branch till the highest point of the 2-yr-old wood. At the end of the trial, trees were rated with a growth index where 1 = very weak trees to 9 = very vigorous trees.

In the Netherlands, through the period of 1994 to 1998, leaf analyses were done for N, P, K, Ca and Mg and a few times for Mn and Zn. A mixed sample of 60 leaves was taken of the third and fourth leaves from the base of the shoots from all replicates in early August. After digestion of samples in sulpuric acid an Alpkem continuous flow analyser was used to determine N and P. The other elements were estimated by atomic absorbtion spectroscopy.

At the end of the trial at the Wilhelminadorp location, trunks of some treatments were sawed longitudinally to observe the condition of the graft unions.

Annually, the flowering intensity of the trees was rated in Wilhelminadorp and Velm according to the following scale, 1 = no flowers to 9 = abundant flowering. During harvest, each year and at all sites, fruits per tree were counted and weighed. At all sites, 'Conference' was size-graded in 5 mm classes during the years 1995-1998, but at Zeewolde grading was omitted in 1998. From the data, mean fruit weight (g), and accumulated fruit number per m^3 and per cm^2 trunk cross-sectional area (TCA) were calculated. At Wilhelminadorp and Zeewolde, during 1994-1996, fruit analyses were done for N, P, K, Ca and % dry matter was determined. To that end, a mixed sample of 25 to 35 pears in the most common diameter class was collected from all replicates at harvest and analyzed as indicated for the leaf analysis.

Important parameters were analyzed using the statistical package Genstat 5, version 3.2. Significant F-tests ($P < 0.05$) were followed by a LSD-test for pair wise comparison of the treatment means using $LSD_{0.05}$ values. Data of the two cultivars were analyzed together and combined for all sites or analyzed separately.

Results

Vegetative characters and winter hardiness

The percentages of successful grafts one year after grafting were: 92 (control), 89 (BA), 96 (BH), 91 (DC), 93 (FB), 97 (NP) and 98 (OH). Clearly, graft take of the interstems on the Quince MC rootstock was good. During the 1988 season, control trees developed better than interstem trees in the nursery. When the trees were planted in early 1989, interstem trees had very few or no laterals, whereas control trees of 'Conference' bore 4.7 laterals per tree with an average length of 35 cm and 'Doyenné du Comice' 4.1 laterals with an average length of 35 cm. During the first growing season, interstem trees developed well, especially on the BH and DC interstems. In the second year, however, control trees produced more shoot growth, probably because there was more twig length at planting. After four growing seasons, no significant interaction was observed between interstem and cultivar or site for tree volume. Averaged for all sites and the two cultivars the volumes were: control 1.00, BA 0.43, BH 0.86, DC 0.82, NP 0.70 and OH 0.78 m^3 (F test ***, $LSD_{0.05} = 0.07$). FB could not be included in this calculation, because it was not present at all sites. At Wilhlminadorp, the volume of 'Conference' trees on FB was significantly smaller than that of NP, but significantly greater than that on BA. For 'Doyenné du Comice' trees, the tree volume of FB equalled DC and NP. After ten growing seasons, cultivars were analysed separately because in that way FB could be included for 'Conference.' Again, there was no interaction between site and interstem (Table 1). DC and OH trees had a similar tree volume as the controls for both cultivars. 'Conference' trees, with BH interstems, were also similar to the controls. The other interstems produced trees with smaller tree volumes. BA trees had the smallest tree crowns. Since pruning will have affected tree volume, the circumference of the scion trunk above the interstem is probably a better parameter for vigor. However, since significant interactions occurred, the data for the sites are presented separately (Table 1). For both cultivars, BA clearly had the thinnest scion trunks. The data for the remaining interstems was more variable. NP at the Velm location and FB at the Wilhelminadorp location reduced the vigor of 'Conference' trees, but at Zeewolde, interstem trees were either equal in vigor to the control or even more vigorous as was the case with DC, NP, and OH interstems. For 'Doyenné du Comice' trees, interstems provided no growth reduction at Velm or as with OH interstems, even increased vigor. At the Wilhelminadorp and Zeewolde locations, BH, DC and NP reduced growth, while OH promoted it.

BA trunks were the thinnest and FB trunks also tended to be smaller than controls for both cultivars (Table 1). For 'Con-

ference' trees, the trunks of all other interstems were equal in size to the control or even larger, especially OH. However, OH was only significantly larger at the Wilhelminadorp and Zeewolde locations. With 'Doyenné du Comice,' DC and NP remained significantly thinner than the controls in all sites. At Wilhelminadorp, all interstems were thinner than the control.

Everywhere, the trunks of BA remained thin in relation to the scion and BH proved to have a relatively thick interstem, having the largest ratio in all sites (Table 1). Differences between these two extremes and the other treatments were not always significant, but everywhere the BA ratio was significantly smaller than that of BH.

For both cultivars, OH interstems produced the greatest increase in trunk size for both scion and interstem, although the increase in circumference was significant only at Wilhelminadorp (Table 1). NP also induced more growth than in control trees at the Wilhelminadorp location, but significantly only with the 'Doyenné du Comice' scions. In all other cases, the scions grew equally well, even on BA. With the exception of OH, all other interstems developed equally strong with 'Conference.' With 'Doyenné du Comice' the BA interstem remained thinner than all others. The increase in scion trunk circumference from fall 1993 until 1998 may be indicative of future tree vigor as the growth in the last five years probably was no longer greatly influenced by the differences in plant material (Table 1). The growth index data that were obtained in the last year of the trial, revealed that for both cultivars and at all sites, BA significantly lagged behind the other treatments with respect to growth. With 'Conference,' FB also reduced growth in the three sites, as did NP at Wilhelminadorp. With 'Doyenné du Comice,' no further differences were apparent at the Velm or Zeewolde locations. However, at the Wilhelminadorp location, NP and OH had similar growth index values to the control, the others being weaker (data not shown). Leaves of trees on BA and FB looked slightly less green than those of the other treatments, but none of the interstems affected the leaf concentrations of N, P, K, Ca, Mg, Mn or Zn that were determined in 1994, 1996 or 1998 (data not shown). Longitudinal trunk cuts made after removing the trial at the Wilhelminadorp location, revealed that BA and to a lesser extent FB had not knitted well with the Quince MC rootstock. These obervations suggest possible incompatibility between these interstems and Quince MC. The other interstems and the controls had good connections with the rootstock. Root suckering around the trunk base was scarce and no differences between the treatments were observed.

During the experimental period no damaging freezes occurred, therefore no conclusions could be drawn as to the winter hardiness of the interstems used in the study.

Generative characters

The interstem did not influence the annual bloom ratings at the Velm and Wilhelminadorp locations. The trees began cropping in 1991 at all sites, with the exception of 'Doyenné du Comice' trees at Velm. Cropping began at Velm in 1992, because a spring frost in 1991 caused damage to the flowers which resulted in no fruit set. The smaller trees on BA produced less fruits per tree than the other treatments (Table 2).

Since the amount of fruit production is confounded by tree size, the data in Table 2, which adjust for tree size, may be more relevant. For 'Conference' trees, there were no significant differences in the fruit number per m^3 at Velm. However, at the Wilhelminadorp location, NP followed by DC and FB had higher yields per tree volume and at Zeewolde this was the case with BA. The latter may have been partly due to the small tree volume of BA trees. For 'Doyenné du Comice,' all sites could be combined since no interactions occurred, and there were no differences between the treatments for fruit numbers per tree volume (Table 2). Outcomes differed when yield was adjusted by TCA. 'Conference' trees at the Velm location, had differences in yield per TCA between inter-

stems. Although none of the interstems differed from the control, OH and FB trees had lower yield/TCA than BA, DC and NP. At the Wilhelminadorp and Zeewolde locations, OH produced less fruit/TCA than the control. NP produced higher yields/TCA at both the Velm and Wilhelminadorp locations. Therefore, OH seems a rather unproductive interstem for both 'Conference'and 'Doyenné du Comice.' FB produced well at the Wilhelminadorp location. 'Conference,' fruit size is rather small, and for a good market value should be larger than 55 mm in diameter. Percentages of fruit larger than 55 mm or 65 mm and averaged over all grading years, are shown in Table 3. No differences were observed in percentages of fruit larger than 55 mm, but for percentages of fruit larger than 65 mm, differences were found. At the Velm and Wilhelminadorp locations, fruit from the FB trees had a good fruit size, but that was not the case at the Zeewolde location. At Zeewolde, BA, FB and NP had poorer fruit size.

Elemental analyses for four years of 'Conference' fruit that were harvested at the Wilhelminadorp location (1994-1996, 1998) nor those sampled for three years from the Zeewolde location (1994-1996) had any significant differences between treatments, although fruits of BA trees in some cases had a slightly higher Ca content. Similarly, with 'Doyenné du Comice,' fruit analyses from the Wilhelminadorp location in 1995 and 1996 or from Zeewolde in 1994 and 1996 were not different (data not shown).

Discussion

The aim of the trial was to find an interstem that combined winter hardiness with growth-reducing capacities. As no very severe winter occurred during the experimental period, no conclusions can be drawn with regard to cold hardiness. Growth reduction was obtained (Table 1), but consistently only with a BA interstem. Unfortunately, BA trees at the Wilhelminadorp location were poorly knitted at the graft union with Quince MC and can therefore not safely be recommended. However, on the very good loess soil of Velm, the performance of trees on BA interstem was good and practical use should be considered (11). The reduction in growth of BA was stronger at the Wilhelminadorp location than at Velm or Zeewolde and also the BA interstem was smaller (Table 1). Possibly, on the moderately vigor inducing soils of Wilhelminadorp, incompatibility was more clearly expressed than on the richer soils in V and Z. Differences in compatibility due to variations in growing conditions have also been found earlier (3). The weaker growth of both cultivars on FB and the thinner FB trunk at Wilhelminadorp (Table 1), was also possibly also due to sub-optimal compatibility. Here, too, a rather poor connection between FB and Quince MC rootstock was observed, although not as poor as with BA. Unfortunately, no trunks were cut at Velm or Zeewolde. Therefore, FB should possibly be discarded as a possible interstem for growth control. The other interstems having no dwarfing effects are useless for vigor control. However, these rootstocks, may be useful for other purposes. For example, they may be used to prevent establishment problems with 'Conference' on Quince MC. Both BH and DC have proved to be valuable in this respect (15).

For apple, the thickness of the interstem relative to the scion cultivar has been suggested to be related to growth reduction. When a dwarfing rootstock is used as an interstem on a vigorous rootstock, this results in relatively thick interstems as opposed more vigorous rootstoks (1). A dwarfing apple interstem should 'keep' more nutrients than a non-dwarfing interstem, allowing them to grow in a more radial direction as opposed to an invigorating interstem that remains relatively thin (4, 5). The data presented in Table 1 for BH and OH concur with this hypothesis. The former developed a relatively thick stem and induced less growth in the scions than the relatively thin OH, the most invigorating interstem. However, the size of the OH interstem was not significantly smaller than that of BH. Moreover, OH trunks tended to thicken strongly in the latter part

Table 1. Tree volume, 1998 and 1994-1998 increase in scion and interstem trunk circumference, and the ratio between the interstem and trunk circumference of 'Conference' and 'Doyenné du Comice' pear trees containing 6 interstems that were grafted onto Quince MC rootstock.

Interstem	All Tree Volume (m^3)	Location: Velm Scion trunk circumference cm '98	Velm Scion trunk circumference cm increase '94-'98	W'dorp Scion trunk circumference cm '98	W'dorp Scion trunk circumference cm increase '94-'98	Zeewolde Scion trunk circumference cm '98	Velm Interstem trunk circumference cm '98	Velm Interstem trunk circumference cm increase '94-'98	W'dorp Interstem trunk circumference cm '98	W'dorp Interstem trunk circumference cm increase '94-'98	Zeewolde Interstem trunk circumference cm '98	Velm Ratio between interstem and scion circumference '98	W'dorp Ratio between interstem and scion circumference '98	Zeewolde Ratio between interstem and scion circumference '98
'Conference'														
Control	2.21	26.0	8.6	25.2	7.9	26.1	25.1	8.4	25.1	8.0	27.3	0.97	1.00	1.05
BA	1.52	22.7	8.6	19.2	9.3	22.1	19.7	7.0	18.1	8.4	19.4	0.87	0.94	0.88
BH	2.11	25.1	9.0	24.5	7.7	28.2	25.5	8.6	27.5	8.5	29.4	1.02	1.12	1.05
DC	2.08	25.7	8.1	26.2	8.6	30.2	25.2	8.0	27.8	9.4	28.9	0.98	1.06	0.96
NP	3.03	23.9	9.1	23.8	8.1	29.3	23.7	7.3	25.2	8.7	28.2	0.98	1.06	0.97
OH	2.20	27.8	10.6	27.3	10.7	32.3	26.4	10.6	28.6	11.3	30.0	0.96	1.05	0.93
FB	1.92	26.4	9.6	22.9	7.9	27.1	24.3	8.6	23.7	7.8	25.8	0.94	1.04	0.95
F test	***	***	ns	***	*	***	*	ns	*	**	*	*	***	***
LSD0.05	0.21	2.1	nc	2.1	1.8	2.4	2.1	nc	2.2	1.7	1.6	0.08	0.03	0.02
'Doyenné du Comice'														
Contol	1.87	29.1	11.1	29.7	9.1	32.4	29.8	11.8	30.3	9.9	32.6	1.03	1.02	1.01
BA	1.36	22.7	10.4	18.2	8.6	22.8	20.8	9.2	17.6	8.0	20.4	0.92	0.98	0.89
BH	1.68	27.6	10.5	25.8	9.3	29.4	30.4	11.8	28.2	10.1	30.0	1.09	1.10	1.02
DC	1.73	27.6	11.8	26.4	10.0	30.7	27.6	11.0	27.4	10.5	30.8	1.01	1.04	1.00
NP	1.65	26.9	12.4	25.4	10.5	30.3	27.1	12.0	25.9	10.8	28.3	1.01	1.02	0.93
OH	1.77	34.3	13.8	31.6	12.8	34.3	29.9	12.5	31.5	12.0	30.5	0.97	1.00	0.89
FB	[z]	-	-	[y]	8.6	-	-	-	[x]	9.5	-	-	1.09	-
F test	***	***	ns	***	***	***	**	**	**	***	**	**	***	***
LSD0.05	0.19	2.3	nc	1.7	1.3	2.1	2.2	1.3	1.8	1.4	1.3	0.06	0.05	0.04

nc = not calculated, ns, *, **, *** = not significant, significant ($P < 0.05$), strongly ($P < 0.01$) or very strongly ($P < 0.001$) significant respectively. [z]Not in common analysis, but in separate analysis for Wilhelminadorp, value significantly greater than BA but significantly smaller than all other treatments, except NP. [y]Not in common analysis, but in separate analysis for Wilhelminadorp value significantly higher than for BA and significantly lower than for all other treatments. [x]Ditto, value significantly higher than for BA, equal to that for NP, and significantly higher than for all other treatments.

Table 2. Fruit number, yield density expressed on both tree volume and TCA basis of 'Conference' and 'Doyenné du Comice' pear trees containing 6 interstems that were grafted onto Quince MC rootstock.

Interstem	Velm	W'dorp	Zeewolde	Velm	W'dorp	Zeewolde	All fruit wt (g)	Velm	W'dorp	Zeewolde	All	Velm	W'dorp	Zeewolde	All
	Fruit (No.)			Yield (Kg)				Fruit no/tree volume (m^3)				Fruit no./TCA (cm^2)			
'Conference'															
Control	842	859	856	146	173	153	191	264	530	516		15.9	17.0	15.8	
BA	671	399	704	109	74	119	182	293	510	669		16.4	14.7	17.3	
BH	775	874	866	139	171	155	191	263	583	503		15.5	18.4	14.0	
DC	875	959	924	149	187	163	186	309	647	539		16.6	17.6	12.9	
NP	811	818	1009	130	150	166	176	276	690	572		18.7	18.2	14.9	
OH	818	747	939	131	144	165	184	259	507	518		13.3	12.4	11.4	
FB	700	721	940	119	140	159	186	258	627	549		12.8	17.3	16.2	
F test	***	***	***	***	***	***	***	*	*	*		*	*	*	
$LSD_{0.05}$	105	105	118	18	18	21	5	94	94	105		3.3	3.2	3.6	
'Doyenné du Comice'															
Contol	363	541	326	84	148	90	289				276				6.1
BA	202	216	234	55	60	65	294				237				7.1
BH	306	447	302	80	129	90	309				259				6.5
DC	311	444	323	76	126	88	298				263				6.4
NP	299	402	234	70	108	90	289				266				6.4
OH	354	427	285	76	129	78	287				244				4.6
FB	-	[p]	-	-	[q]	-	[r]				[s]				[t]
F test	***	***	***	***	***	***	***				ns				ns
$LSD_{0.05}$	69	49	62	18	13	16	9				nc				nc

nc = not calculated, ns, *, **, *** = not significant, significant ($P < 0.05$), strongly ($P < 0.01$) or very strongly ($P < 0.001$) significant respectively. [p]Not in common analysis, but in separate analysis for Wilhelminadorp, value significantly higher than for BA, significantly lower than for the control, and not significantly different from all other treatments. [q]Ditto, value significantly higher than for BA, not significantly different from OH, and significantly lower than for the control, BH, and DC. [r]Ditto, value, not significantly different from all other treatments, except DC which had significantly larger fruit. [s]Ditto, value not significantly different from the control, but significantly higher than for all other treatments. [t]Ditto, value significantly higher than for all other treatments.

Table 3. Weight percentage of Conference fruit larger than 55 or 65 mm in diameter averaged for 1995 till 1998.

	> 55 mm			> 65 mm		
Interstem	Velm	W-Dorp	Zeewolde	Velm	W-dorp	Zeewolde
Control	88	94	87	32	55	35
BA	88	97	85	37	54	24
BH	89	95	90	37	54	41
DC	86	94	90	34	49	37
NP	86	95	88	31	42	28
OH	86	95	87	34	52	36
FB	92	97	87	43	56	25
F test	ns	ns	ns	**	#	*
LSD0.05	nc	nc	nc	5	9	12

nc = not calculated. ns, *, ** = not significant, significant ($P < 0.05$) or strongly ($P < 0.01$) significant respectively. # indication for an effect, $F = 0.064$.

of the trial, so that the actual thickness may be a better indicator for vigour than the relative thickness. The data for BA in Table 1 show that BA remained thin in relation to both scion cultivars and reduced growth most, and also the actual size of BA was small. These observations do not fit the hypothesis of Jones (4, 5), however this hypothesis may not apply to incompatible combinations, such as BA on Quince MC.

The OH interstem was the only interstem that affected productivity per unit of growth negatively (Table 2). Therefore, OH does not seem a good choice as interstem. It is noteworthy that the data on cropping per unit of tree volume and per TCA in Table 2 do not agree. For example, OH was significantly less productive at the Wilhelminadorp and Zeewolde locations when fruit number was adjusted by TCA, but this was not the case when fruit number was adjusted by tree volume. The former is the most common parameter for productivity and hence prudence is called for with recommending an OH interstem.

Fruit weight of 'Conference' was negatively affected by several interstems, most of all by NP (Table 2). At Zeewolde, small fruit could have been a result of a high crop load (Table 2), but small fruit were also present at the Velm and Wilhelminadorp locations. Therefore, NP might have a direct negative effect on fruit weight. Still, this effect on fruit size was only important for the larger size classes at Wilhelminadorp.

In conclusion, BH and DC seem the only valuable interstems for 'Conference,' although they do not provide any growth control. However, as stated earlier these interstems could help prevent establishment problems, that may be a consequence of poor graft compatibility with Quince rootstocks (2). All other interstems have disadvantages. With 'Doyenné du Comice,' an interstem is not a high priority with regard to compatibility given its excellent connection with Quince rootstocks (2), but growth control would be very welcome. However, no good candidates were discovered in this research.

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Assessing Budsports of 'Valencia' Sweet Orange (*Citrus sinensis* (L.) Osbeck) for Desirable Characteristics

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Abstract

Three mutant clones of 'Valencia' orange were compared to the standard cultivar. All selections and the source cultivar were grafted onto *Citrus aurantium* L. rootstock and assessed for yield, vigor, fruit quality and other morphological characteristics for a period of four years.

Two clones (A and B) displayed significant improvements over the standard Valencia cultivar. Over 4 consecutive years, major characteristics such as yield, fruit morphology and juice quality were found to be better in clones A and B. Clones A and B gave a greater yield per tree and greater mean fruit weight, while clone A gave a higher endocarp/pericarp ratio and increased endocarp weight. Clones A and B contained more juice per fruit, and higher total soluble solids and vitamin C compared to the standard 'Valencia' clone. Clone B ripened at the same period as main cultivar, while clone A ripened 30-35 days later and clone C 30 days earlier

The improved characteristics and altered ripening time of clones A and B warrant propagation of this plant material and broader testing on a commercial scale.

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