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**Development of Long-term Storage Method
in Fruit Nursery Stock**

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1997. 12. 29

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(Development of Long-term Storage Method in Fruit Nursery Stock)

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SUMMARY

Difficulty in estimating the demands for fruit tree nursery stocks repeatedly has resulted in their over-production or shortage. The surplus nursery stocks due to over-production, in particular, have caused nursery stock producers serious to suffer serious economic losses.

This study, therefore, was carried out to develop storage method for the surplus nursery stocks and thereby to construct an on-demand supply system in nursery stocks.

To determine the optimal storage temperature, nursery stocks of 6 fruit trees were stored at -5 , 0 and 5 before planting in May, June, July, and August. Their growth patterns were measured in October and summarized as follows;

1. Apple 'Fuji' nursery stock stored at 0 showed the highest survival rate and growth of nursery stock after planting, but at 5 storage, its survival rate was less than 20%.
2. For Japanese pear 'Niitaka', the survival rate and growth of nursery stock after planting were higher at 0 and 5 storage than at -5 storage.
3. The survival rate and growth after planting in grape 'Sheridan' nursery stock appeared to be higher at 0 storage than at 5 and -5 storage.
4. The survival rate and growth after planting in peach 'Yumyoung' nursery stock were the highest at 0 storage. The storage at 5 caused a part of nursery stocks to budbreak during storage.
5. The storage at 0 and 5 had higher survival rate and growth after

planting in persimmon 'Fuyu' nursery stock than did the storage at -5 . The budbreak of nursery stock during storage was not found at 5 storage unlike the peach nursery stock.

6. For kiwifruit 'Hayward' nursery stock, the storage temperature appeared to be 0 because of the high survival rate and growth.

To develop the optimal packing method, the nursery stocks of 6 fruit trees were packed with 3 different methods: polyethylene film bag packing (PE); polyethylene film bag packing after spraying nursery stocks with benlate (PE + Benlate); polyethylene film bag packing after spraying nursery stocks with wax (PE + Wax).

After storing at 0 until April, the packed nursery stocks were planted and their survival rate and growth were measured in October. The result were summarized as follows;

1. In apple 'Fuji', the spray of benlate and wax increased the survival rate of nursery stock after planting in comparison with PE, but had no effect on the number of newly developed shoot. The spray of benlate appeared to be effective on the growth of nursery stock after planting.
2. In Japanese pear 'Niitaka', the survival rate and growth of nursery stock after planting were increased with the spray of either benlate or wax. In addition, the spray of benlate was closely related to the increased number of the newly developed shoot.
3. In grape 'Sheridan', the wax spray increased the survival rate of nursery stocks after planting compared with PE, whereas the benlate spray decreased

the survival rate and growth.

4. In peach 'Yumyoung', the benlate spray showed the best growth of nursery stock after plating of all packing methods with considerably high survival rate and growth.
5. In persimmon 'Fuyu', all packing methods including PE had the considerable survival rate and growth of nursery stocks after planting. The benlate spray increased somewhat the growth of them.
6. In kiwifruit 'Hayward', PE showed the highest survival rate and growth of nursery stocks after planting.

To develop the supplemental planting method during growing season, the nursery stocks of 6 fruit trees were stored at 0 °C from March for planting in April, May, June, July and August, respectively. The nursery stocks planted after stepwise heating were measured on survival rate and growth. The obtained results were summarized as follows;

1. In apple 'Fuji', the survival rate and growth of nursery stock after planting decreased with delay of planting time. In particular, the planting without heating in July showed the lowest survival rate (<20%). Heating treatment had no effect on the growth after planting.
2. In Japanese pear 'Naitaka', all planting times showed the high survival rate of nursery stock after planting (>80%), without differences among planting times. The growth after planting appeared to be higher with the planting in June than in April, May and August.
3. In grape 'Sheridan', the planting in April, May and June showed about 65%

of the survival rate of nursery stock after planting, but planting in July and August below 20%. The growth after planting was also related with planting time in a same manner.

4. In peach 'Yumyoung', the survival rate of nursery stocks after planting appeared to be considerably high in all planting times and heating treatment except for the planting in July without heating and the planting in August with 0 -10 -20 stepwise heating treatment. The planting after July showed unfavorable growth after planting.
5. In persimmon 'Fuyu', the highest survival rate and growth of nursery stocks after planting were obtained with the planting in June without heating and with 0 -5 -10 -15 -20 stepwise heating.
6. In kiwifruit 'Hayward', the planting in May and June with 0 -10 -20 stepwise heating showed good survival rate and growth of nursery stocks after planting. The 0 -5 -10 -15 -20 stepwise heating caused the nursery stocks to budbreak during the heating treatment.

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Table 1. Production and supply of fruit nursery stock yearly.

<Unit:Trees>

	1990	1991	1992	1993
Production	6,439,000	6,040,400	6,142,400	6,531,200
Supply	5,506,000	4,097,400	4,086,500	5,700,000
Surplus (%)	933,000 (14.5)	1,943,000 (32.2)	2,055,900 (33.5)	831,200 (12.7)

Association of Korea Fruit nursery stock

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1000 0.05mm Polyethylene(PE) film

1 3 5
, 25 1 × 0.5m
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10
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Dry Oven
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N 500mg (98% H₂SO₄) 7mL
(K₂SO₄ CuSO₄ 9:1g) 5g Kjeldahl 360 2
Automatic nitrogen analyzer(Distillation unit Büchi 322, Control unit Büchi
342, Autotitrator E 526, Dosimat 666, Epson HX-20)
N 500mg 100mL flask ,
ternary solution(HNO₃:H₂SO₄:HClO₄ = 10:1:4 volume) 10mL
220 2
P tube 5mL 30 incubator
15 (uv/vis Spectrophotometer, Gilford 260) 470nm
OD
K, Ca, Mg (Atomic absorption spectrophotometer, Perkin
Elmer 2380)
200mg 100mL flask 0.7N HCl
20mL 가 2 30
100mL fill-up 5mL 2.5mL 30
. 0.2% Anthrone 6mL 가 , 100

Spectrophotometer, Gilford 260) 640nm OD .

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 (Fig. 1). +5

2)

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 (Fig. 2).

3)

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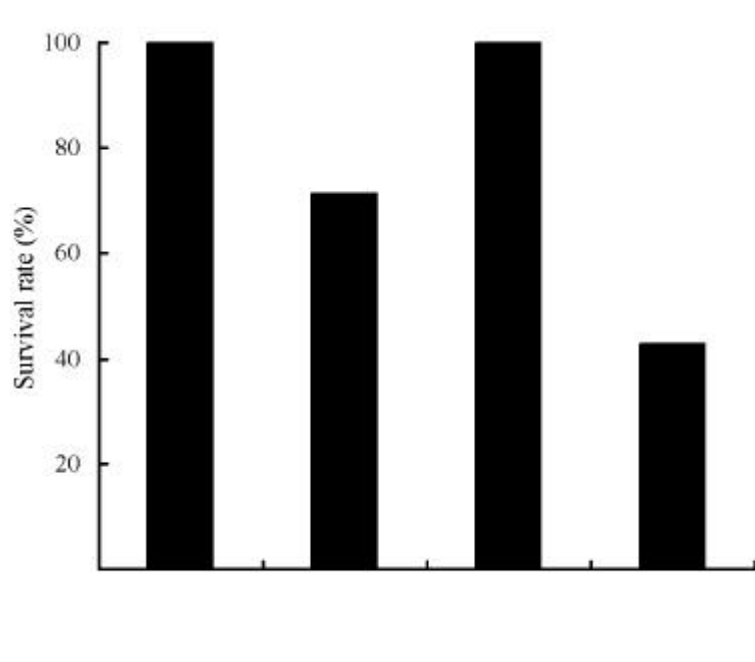


Fig. 1. Survival rate of apple 'Fuji' nursery stock by storage temperature.

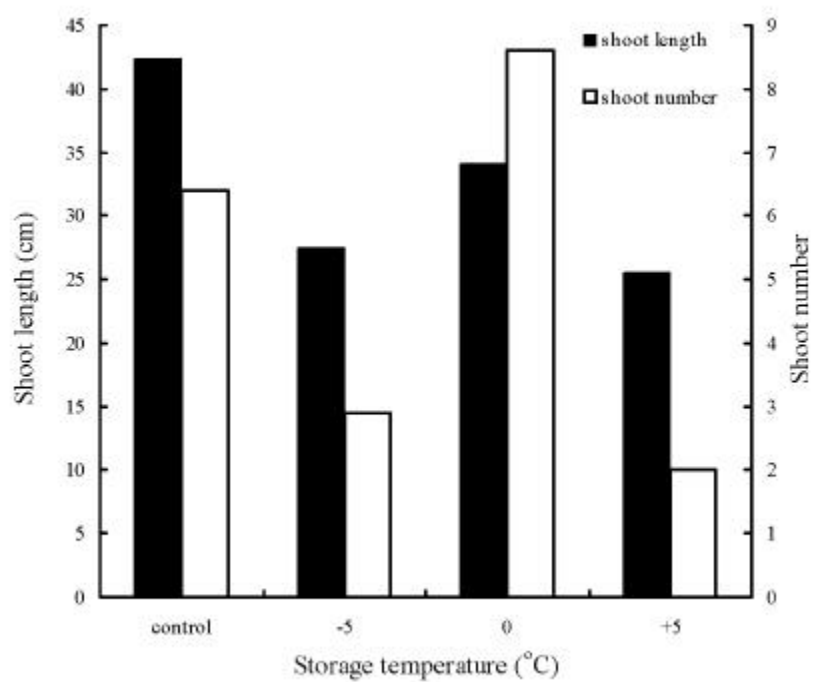


Fig. 2. Shoot length and shoot numbers of apple 'Fuji' nursery stock by storage temperature.

8 가 가 . +5
 -5 3 가 (Fig. 2).
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0 가 가 .

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 (Fig. 3).

2) , +5
 0 (Fig. 4).

3) 가 0 +5
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 가 (Fig. 4).

, 5 0
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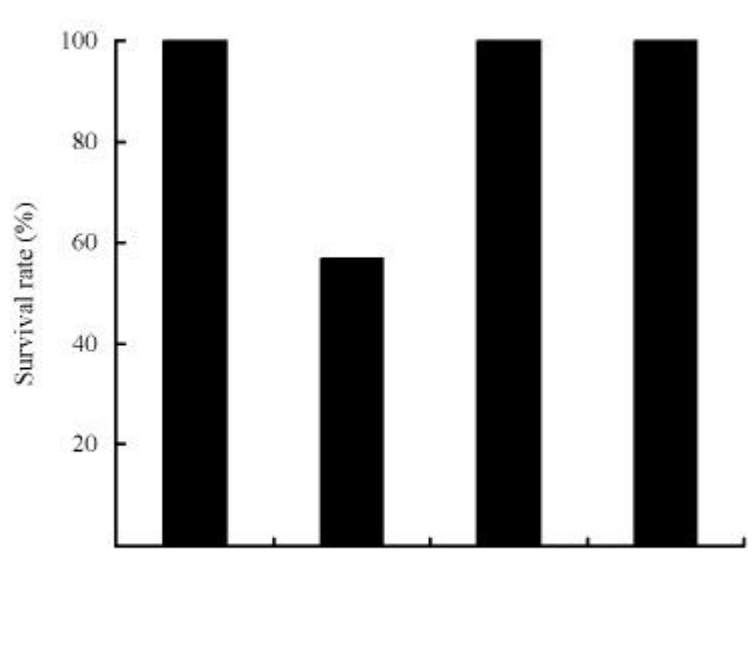


Fig. 3. Survival rate of pear 'Niitaka' nursery stock by storage temperature.

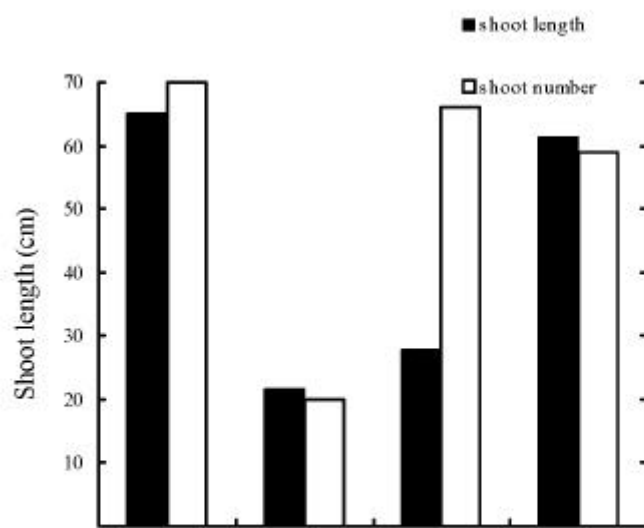


Fig. 4. Shoot length and shoot numbers of pear 'Niiitaka' nursery stock by storage temperature.

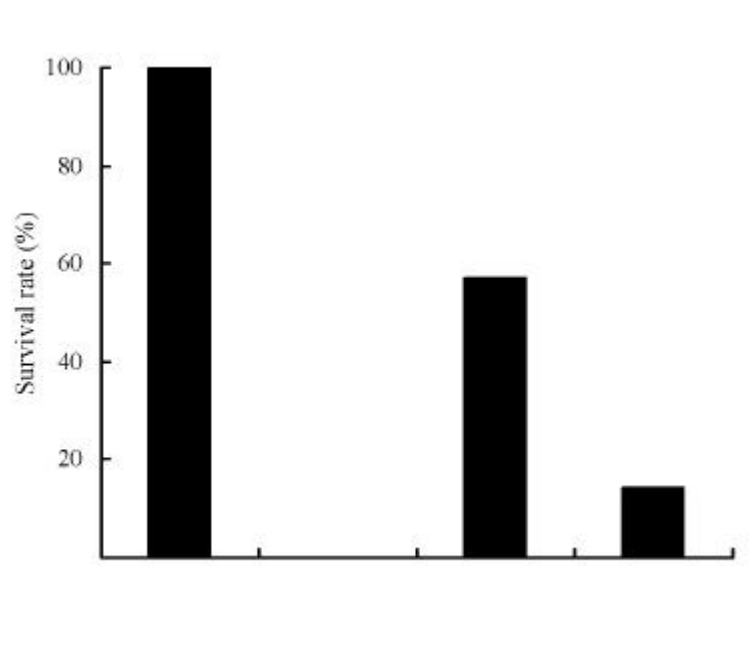


Fig. 5. Survival rate of grape 'Sheridan' nursery stock by storage temperature.

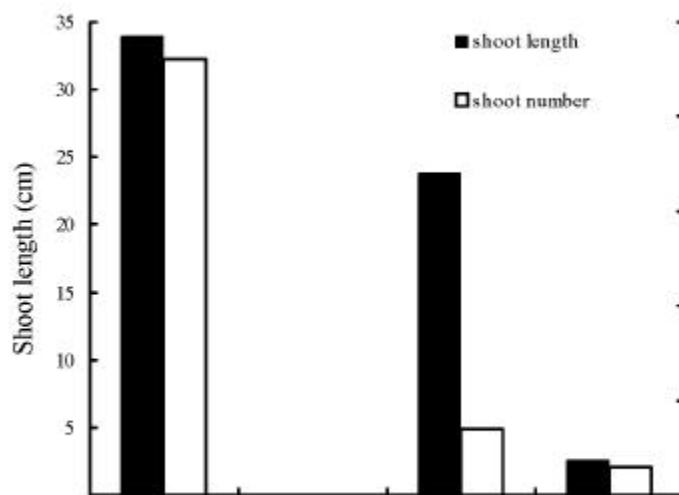


Fig. 6. Shoot length and shoot numbers of grape 'Sheridan' nursery stock by storage temperature.

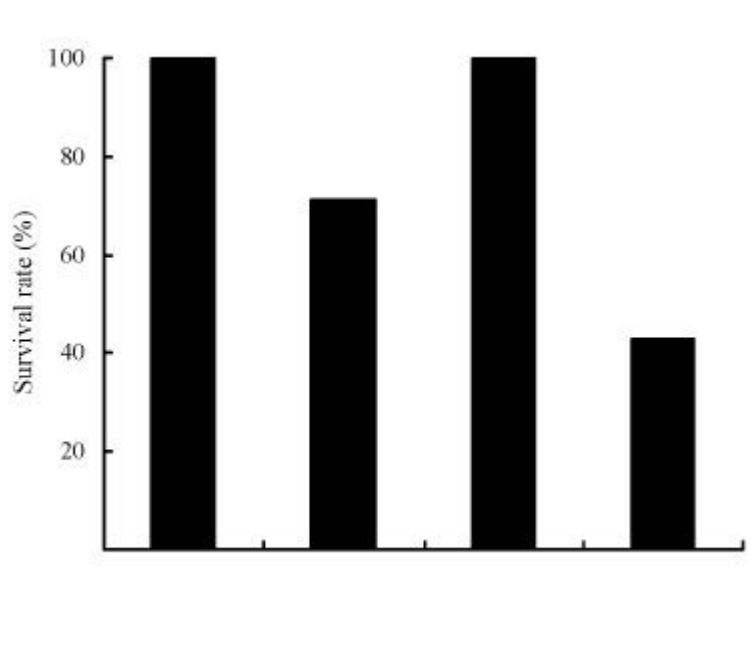


Fig. 7. Survival rate of peach 'Yumyoung' nursery stock by storage temperature.

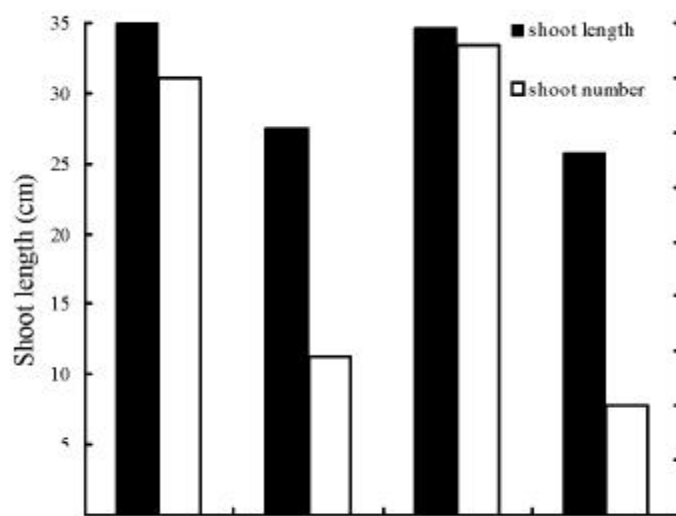


Fig. 8. Shoot length and shoot numbers of peach 'Yumyoung' nursery stock by storage temperature.

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 100% . -5
 60% . +5
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(Fig. 9).

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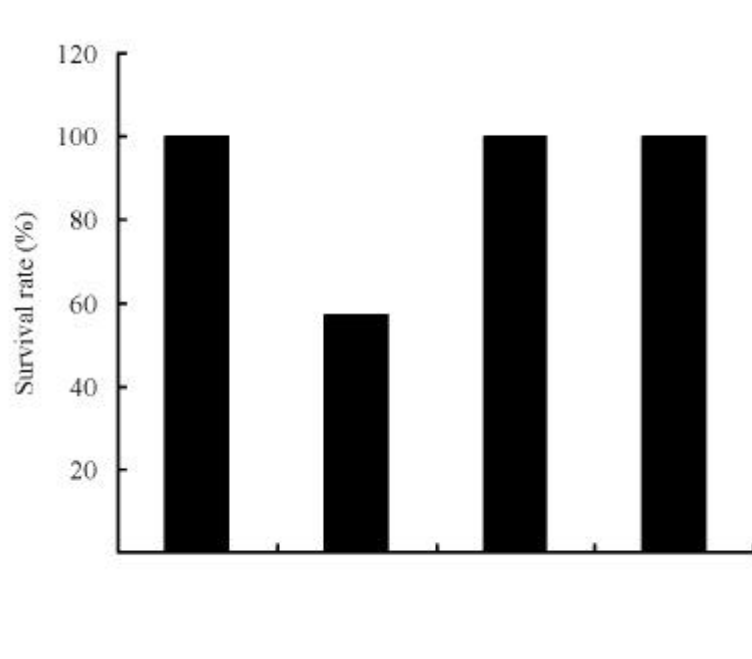


Fig. 9. Survival rate of persimmon 'Fuyu' nursery stock by storage temperature.

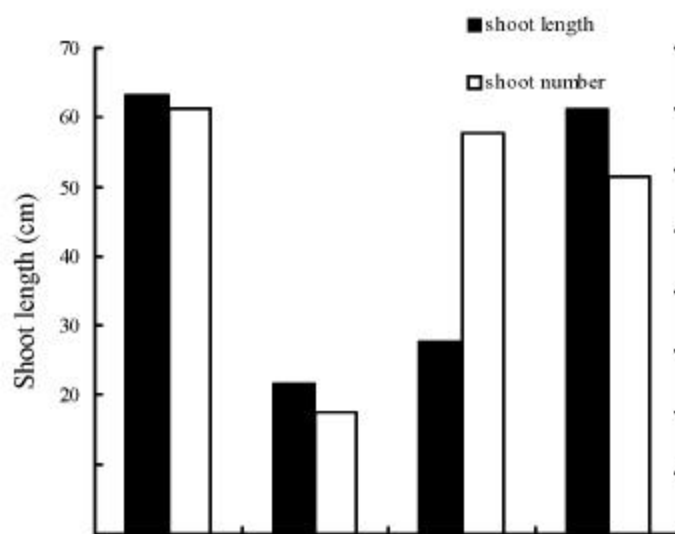


Fig. 10. Shoot length and shoot numbers of persimmon 'Fuyu' nursery stock by storage temperature.

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(Fig. 12).

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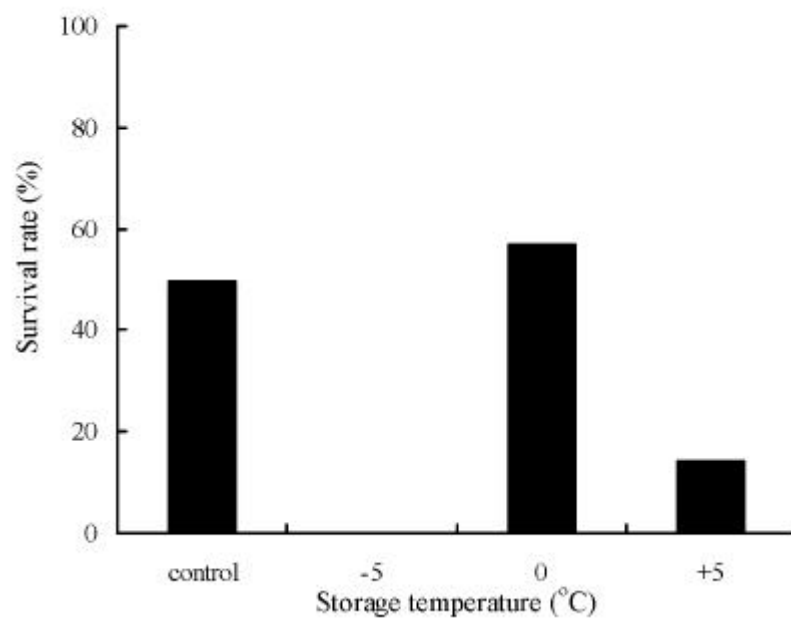


Fig. 11. Survival rate of kiwifruit 'Hayward' nursery stock by storage temperature.

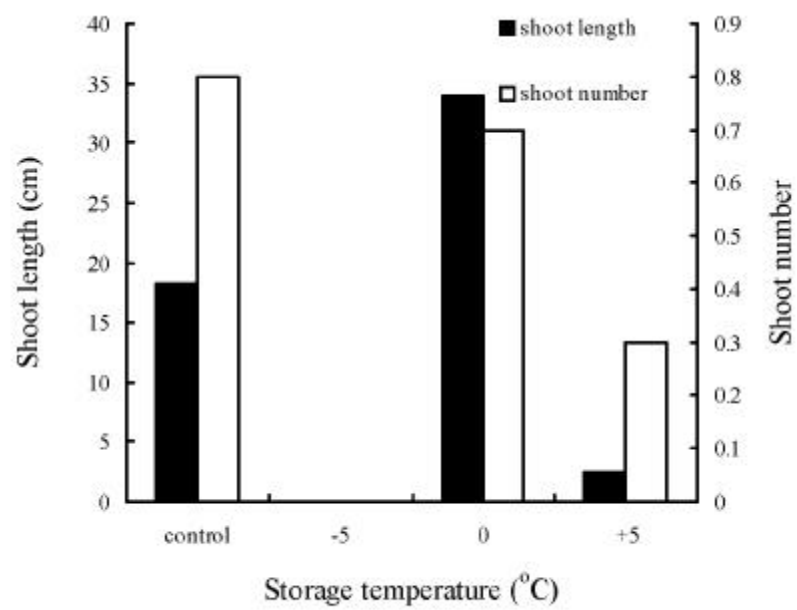


Fig. 12. Shoot length and shoot numbers of kiwifruit 'Hayward' nursery stock by storage temperature.

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N, P, K, Ca, Mg

0 +5 -5

2,3,4,5,6,7, 6

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Table 2. Mineral and carbohydrate content in stem and root of 'Fuji' apple fruit nursery stock to different storage temperature after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Stem						
Control	0.815az	0.103a	0.630a	0.733a	0.097a	8.5a
-5	0.634b	0.080ab	0.532b	0.423bc	0.067b	6.4b
0	0.662b	0.074b	0.554b	0.554b	0.069b	6.1b
+5	0.521c	0.054c	0.432c	0.378c	0.040c	4.4c
Root						
Control	1.540a	0.200a	0.989a	0.233a	0.074a	10.5a
-5	1.240b	0.151b	0.662b	0.152bc	0.050b	7.4b
0	1.340ab	0.143b	0.714b	0.171b	0.059b	7.7b
+5	0.921c	0.101c	0.592c	0.137c	0.040c	5.9c

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

Table 3. Mineral and carbohydrate content in stem and root of 'Niiitaka' pear fruit nursery stock to different storage temperature after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Stem						
Control	0.843az	0.173a	0.720a	0.735a	0.078a	9.5a
-5	0.702b	0.158ab	0.512b	0.523b	0.069ab	7.1b
0	0.689b	0.137b	0.444bc	0.604ab	0.059b	6.1bc
+5	0.500c	0.093c	0.392c	0.470c	0.042c	5.0c
Root						
Control	1.152a	0.296a	1.261a	0.321a	0.062a	12.5a
-5	1.240b	0.151b	0.662b	0.152bc	0.050b	7.4b
0	1.340ab	0.143b	0.714b	0.171b	0.059b	7.7b
+5	0.921c	0.101c	0.592c	0.137c	0.040c	5.9c

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

Table 4. Mineral and carbohydrate content in stem and root of 'Sheridan' grape fruit nursery stock to different storage temperature after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Stem						
Control	0.755az	0.203a	0.620a	0.543a	0.100a	7.9a
-5	0.562b	0.149b	0.532a	0.423b	0.077b	6.6b
0	0.502b	0.128bc	0.554a	0.490a	0.062b	6.0b
+5	0.418c	0.100c	0.401b	0.298c	0.048c	5.4c
Root						
Control	1.286a	0.578a	0.510a	0.253a	0.090a	9.9a
-5	0.892b	0.430b	0.498a	0.229a	0.067b	8.0b
0	0.992b	0.408b	0.421b	0.199b	0.059b	7.5b
+5	0.701c	0.294c	0.400b	0.154c	0.041c	6.1c

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

Table 5. Mineral and carbohydrate content in stem and root of 'Yumyoung' peach fruit nursery stock to different storage temperature after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Stem						
Control	1.245az	0.183a	0.590a	1.023a	0.137a	11.5a
-5	0.935b	0.091b	0.375b	0.826b	0.077b	8.3b
0	0.843bc	0.094b	0.355b	0.932ab	0.062b	7.3bc
+5	0.772c	0.073c	0.263c	0.550c	0.077b	6.4c
Root						
Control	1.598a	0.279a	0.760a	0.803a	0.101a	17.2a
-5	0.845bc	0.183b	0.700a	0.710ab	0.099a	12.1b
0	0.992b	0.177b	0.504b	0.723ab	0.100a	13.2b
+5	0.800c	0.123c	0.495b	0.659b	0.072b	9.9c

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

Table 6. Mineral content and carbohydrate in stem and root of 'Fuyu' persimmon fruit nursery stock to different storage temperature after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Stem						
Control	1.524az	0.099a	0.830a	0.613a	0.062a	8.5a
-5	1.028b	0.083ab	0.737ab	0.376b	0.059a	5.3b
0	0.929b	0.079b	0.797ab	0.409b	0.052a	5.1b
+5	0.660c	0.625c	0.650b	0.388b	0.040b	3.4c
Root						
Control	1.944a	0.180a	1.270a	0.579a	0.053a	10.4a
-5	1.298b	0.175ab	0.990ab	0.376b	0.050a	8.8b
0	0.929bc	0.169ab	0.929ab	0.359b	0.052a	8.7b
+5	0.830c	0.155b	0.810b	0.380b	0.030b	6.0c

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

Table 7. Mineral and carbohydrate content in stem and root of 'Hayward' kiwifruit nursery stock to different storage temperature after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Stem						
Control	0.585az	0.133a	0.440a	0.393a	0.082a	6.9a
-5	0.449ab	0.110b	0.302b	0.266b	0.065b	5.4b
0	0.402b	0.109b	0.299b	0.250b	0.069b	5.3b
+5	0.302c	0.099b	0.192c	0.180c	0.060b	3.9c
Root						
Control	0.965a	0.283a	0.610a	0.323a	0.060a	8.3a
-5	0.802ab	0.277a	0.570a	0.292a	0.055b	6.4b
0	0.729b	0.270a	0.588a	0.300a	0.050b	6.7b
+5	0.503c	0.255b	0.310b	0.199b	0.039c	3.9c

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

4 .

가

가

가

가

,

.

1.

- 1) 0 (control)
- 2) PE film 0
- 3) (1000) + PE film 0
- 4) Wax + PE Film 0

2. , , , 2

.

3 .

1.

가.

1)

‘ ’ , (control) ,
100% (Fig. 13).

2)

(control) 40cm , PE+
75cm 가
PE+Wax PE

(Fig. 14).

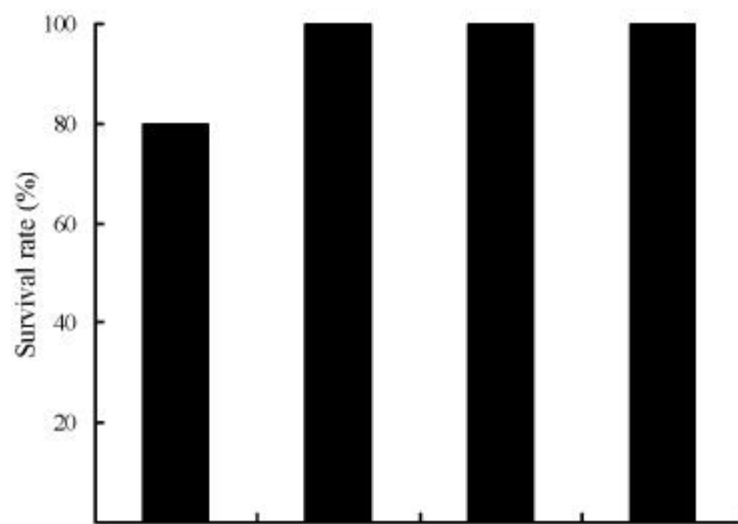


Fig. 13. Survival rate of apple 'Fuji' nursery stock by storage method.

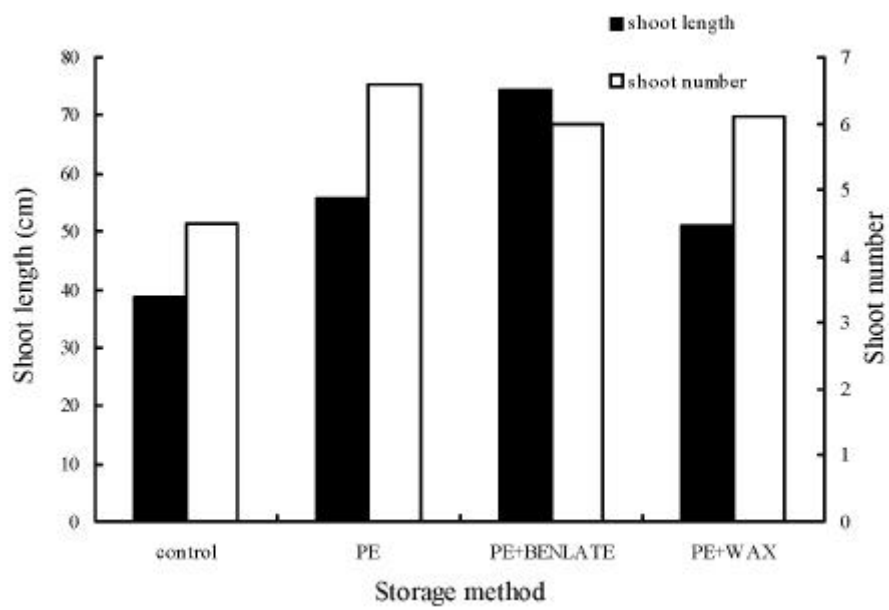


Fig. 14. Shoot length and shoot numbers of apple 'Fuji' nursery stock by storage method.

3)

(control) 4 가
6 가 가 가 가
(Fig. 14).

,
PE+

1)

‘ ’ (control) ,
100% (Fig. 15).

2)

, (control) 20cm 가
, 50cm (Fig. 16).

3)

, (control) 3 가
4-6 가 가
가 가 . PE film
가 가 (Fig. 16).

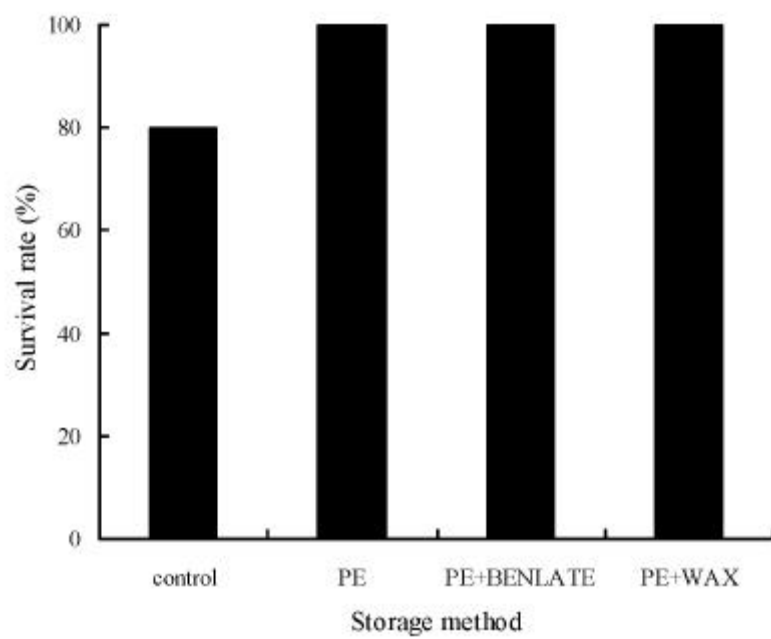


Fig. 15. Survival rate of pear 'Niitaka' nursery stock by storage method.

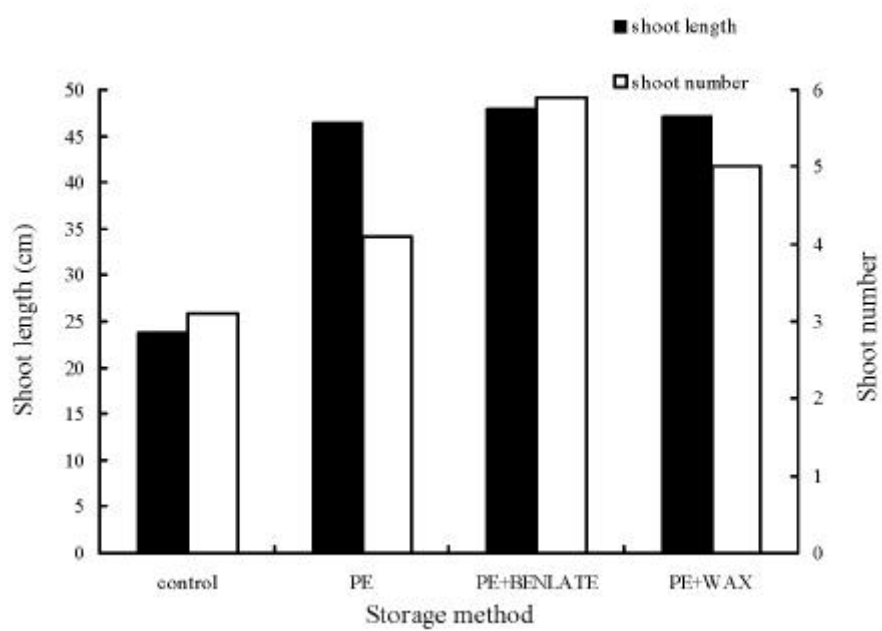


Fig. 16. Shoot length and shoot numbers of pear 'Niiitaka' nursery stock by storage method.

•

1)

‘ , PE film Wax
70%가 가 , PE
40%

(Fig. 17).

2)

(control) 20cm 가 , PE film
80cm 가 가 PE+
30cm 가 가
PE+Wax 40cm가

(Fig. 18).

3)

가 4 가 가 PE film
PE+Wax PE+
(Fig. 18).

Control 가 가
가 .
가 .

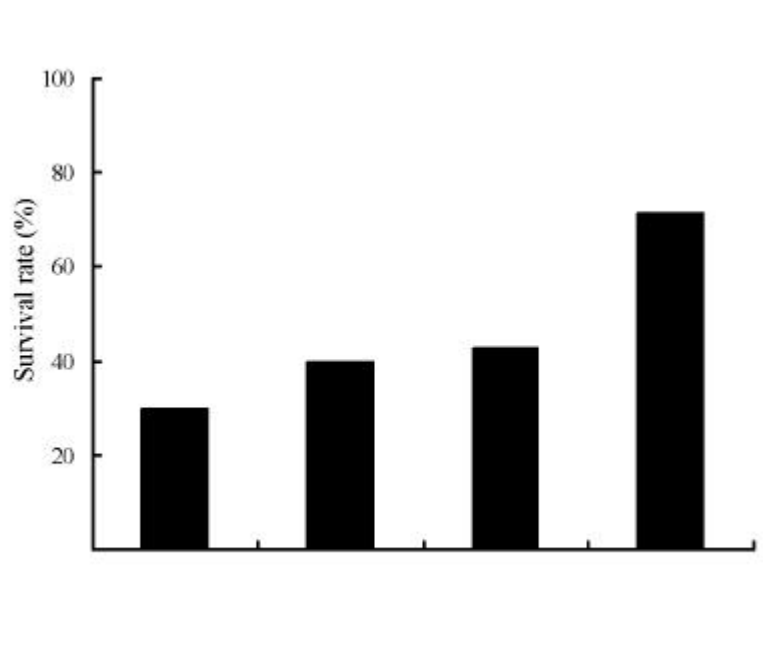


Fig. 17. Survival rate of grape 'Sheridan' nursery stock by storage method.

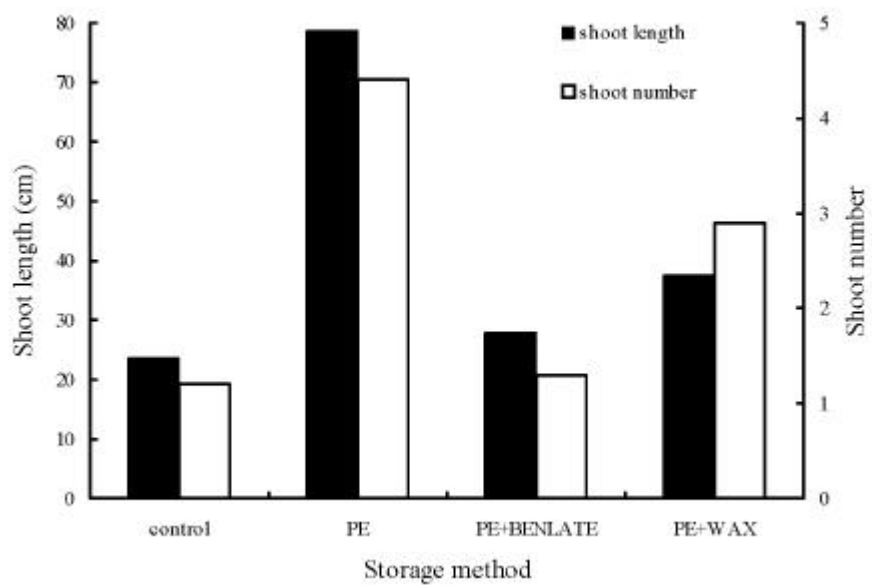


Fig. 18. Shoot length and shoot numbers of grape 'Sheridan' nursery stock by storage method.

•
1) ‘ ’ , (Fig. 19).

2) , (control)
PE+ 70cm
가 (Fig. 20).

3) 6
가 (Fig. 20).

•
1) ‘ ’ (Fig. 21).

2) 가
가 (Fig. 22).

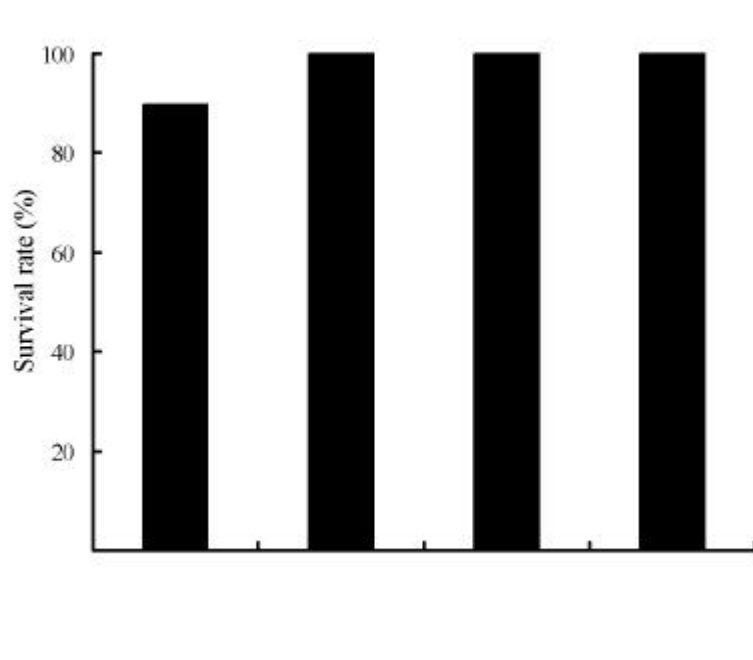


Fig. 19. Survival rate of peach 'Yumyoung' nursery stock by storage method.

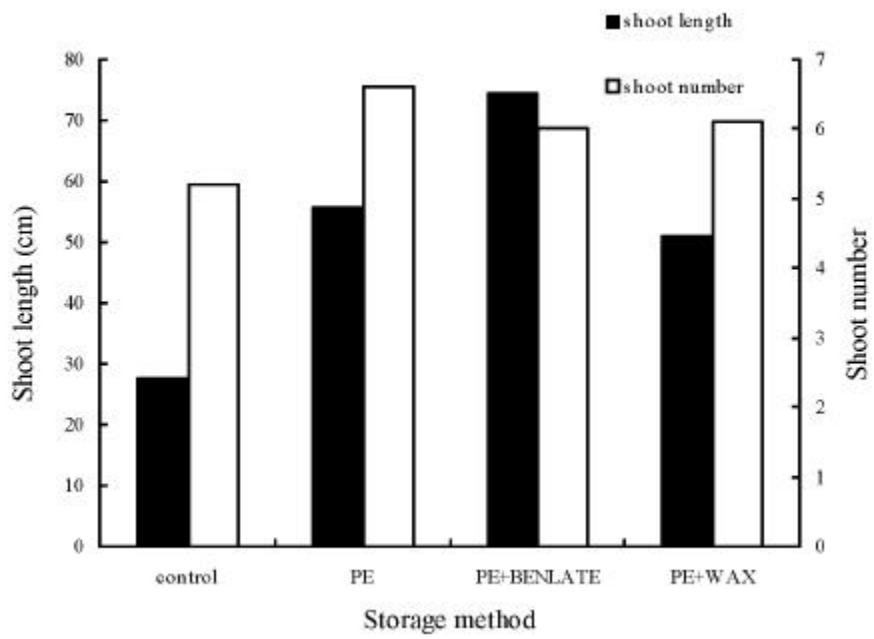


Fig. 20. Shoot length and shoot numbers of peach 'Yumyoung' nursery stock by storage method.

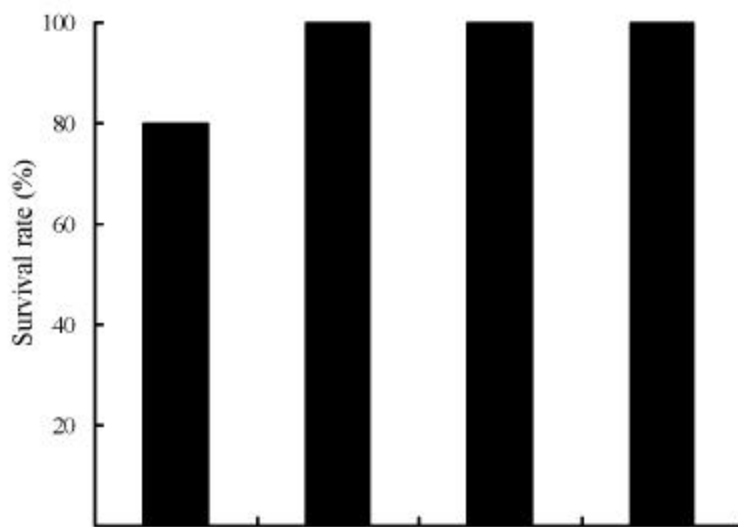


Fig. 21. Survival rate of persimmon 'Fuyu' nursery stock by storage method.

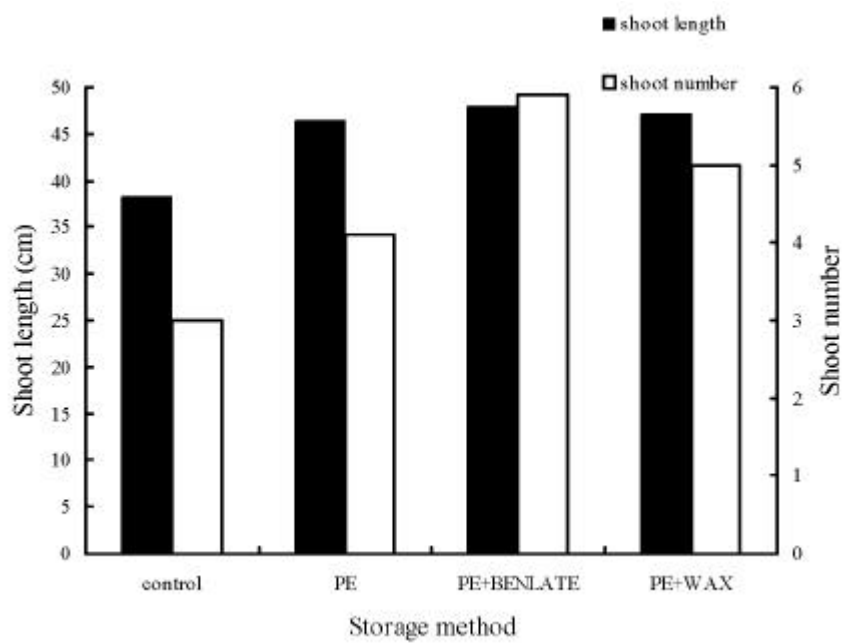


Fig. 22. Shoot length and shoot numbers of persimmon 'Fuyu' nursery stock by storage method.

3)

가 , PE film , 가
(Fig. 22).

PE film 가

1)

PE film Wax
80%가 (Fig. 23).

2)

(control) 20cm 가 , PE film
80cm 가 가 PE+
30cm 가 가
PE+Wax 40cm가
(Fig. 24).

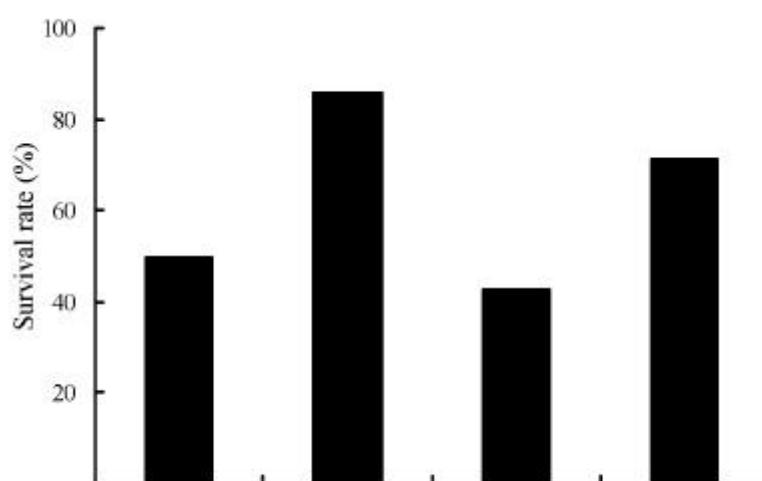


Fig. 23. Survival rate of kiwifruit 'Hayward' nursery stock by storage method.

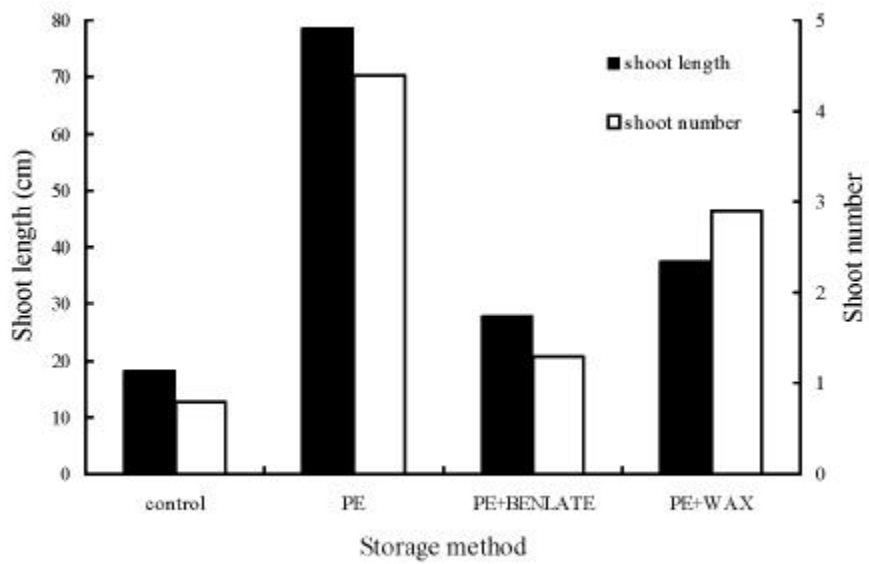


Fig. 24. Shoot length and shoot numbers of kiwifruit 'Hayward' nursery stock by storage method.

3)

가 4 가 가 PE+Wax PE film PE+ (Fig. 24).

2.

N, P, K, Ca, Mg (control) , ' ' (Table 8), ' ' , wax (Table 9). ' ' , (control) , (Table 10), ' ' , PE film (Table 11). ' ' , (control) , (Table 12), ' ' , PE film Wax (Table 13).

Table 8. Mineral and carbohydrate content in stem of 'Fuji' apple fruit nursery stock to different storage methods after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Initialz	0.815ax	0.103a	0.630a	0.733a	0.097a	8.5a
controly	0.546c	0.067c	0.487c	0.490c	0.045b	5.5c
P.E. film	0.658b	0.070b	0.560b	0.623b	0.089a	7.0b
P.E. film +Benlate	0.684b	0.086ab	0.554b	0.650b	0.090a	6.9b
P.E.+Wax	0.690b	0.088ab	0.562b	0.663bc	0.090a	6.8b

z) One year old nursery stock without storage

y) nursery stock with storage at 0

x) Mean separation within columns by Duncan's multiple range test, 5% level.

Table 9. Mineral and carbohydrate content in stem of 'Niiitaka' pear fruit nursery stock to different storage methods after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Initialz	0.843ax	0.173a	0.720a	0.735a	0.078a	9.5a
controly	0.588c	0.099c	0.412c	0.590b	0.069a	5.5c
P.E. film	0.689b	0.121b	0.512b	0.537c	0.071a	7.8b
P.E. film +Benlate	0.744ab	0.158ab	0.539b	0.612b	0.068a	8.7ab
P.E.+Wax	0.701b	0.139b	0.520b	0.660ab	0.072a	8.0b

z) One year old nursery stock without storage

y) nursery stock with storage at 0

x) Mean separation within columns by Duncan's multiple range test, 5% level.

Table 10. Mineral and carbohydrate content in stem of 'Sheridan' grape fruit nursery stock to different storage methods after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Initialz	0.755ax	0.203a	0.620a	0.543a	0.100a	7.9a
controly	0.520c	0.108d	0.411c	0.319c	0.052c	5.6c
P.E. film	0.670ab	0.159b	0.587ab	0.442b	0.073b	6.9ab
P.E. film +Benlate	0.556b	0.130c	0.534b	0.450b	0.066b	6.0b
P.E.+Wax	0.700a	0.170ab	0.560b	0.478b	0.062b	6.1b

z) One year old nursery stock without storage

y) nursery stock with storage at 0

x) Mean separation within columns by Duncan's multiple range test, 5% level.

Table 11. Mineral and carbohydrate content in stem of 'Yumyoung' peach fruit nursery stock to different storage methods after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Initialz	1.245ax	0.183a	0.590a	1.023a	0.137a	11.5a
controly	0.799d	0.073c	0.277c	0.570c	0.096b	7.0c
P.E. film	0.820c	0.084bc	0.380b	0.826b	0.084b	8.3b
P.E. film +Benlate	0.930b	0.102b	0.369b	0.941ab	0.070c	8.0b
P.E.+Wax	0.812c	0.090b	0.360b	0.944ab	0.089b	7.3bc

z) One year old nursery stock without storage

y) nursery stock with storage at 0

x) Mean separation within columns by Duncan's multiple range test, 5% level.

Table 12. Mineral and carbohydrate content in stem of 'Fuyu' persimmon fruit nursery stock to different storage methods after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Initialz	1.524ax	0.099a	0.830a	0.613a	0.062a	8.5a
controly	0.701c	0.688c	0.700b	0.400b	0.040b	4.4c
P.E. film	1.028b	0.080b	0.755ab	0.424b	0.059a	5.3b
P.E. film +Benlate	0.989b	0.080b	0.801a	0.412b	0.052a	5.4b
P.E.+Wax	1.020b	0.081b	0.790a	0.421b	0.053a	5.1b

z) One year old nursery stock without storage

y) nursery stock with storage at 0

x) Mean separation within columns by Duncan's multiple range test, 5% level.

Table 13. Mineral and carbohydrate content in stem of 'Hayward' kiwifruit nursery stock to different storage methods after storage.

Treatment	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
Initialz	0.585ax	0.133a	0.440a	0.393a	0.082a	6.9a
controly	0.312c	0.083d	0.221c	0.211c	0.051b	4.2d
P.E. film	0.449a	0.121b	0.309b	0.266b	0.062b	5.5b
P.E. film +Benlate	0.398b	0.109c	0.310b	0.220c	0.067b	4.8c
P.E.+Wax	0.433a	0.123b	0.297b	0.242b	0.067b	5.3b

z) One year old nursery stock without storage

y) nursery stock with storage at 0

x) Mean separation within columns by Duncan's multiple range test, 5% level.

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4

1 .

가 (5 -8) 가
10% . 1
가 .
가 가

2 .

1 ‘ ; ‘ ; ‘ ; 1 , 2
‘ ; ‘ ; ‘ ’ 1
4 1 0 5 - 8
,
24 0 - 5 - 10 - 15 - 20
48 0 - 10 - 20 .
, , ,

1.

1) 4 (control)

2) 5 0 -
 0 - 5 - 10 - 15 - 20
 0 - 10 - 20

3) 6 0 -
 0 - 5 - 10 - 15 - 20
 0 - 10 - 20

4) 7 0 -
 0 - 5 - 10 - 15 - 20
 0 - 10 - 20

5) 8 0 -
 0 - 5 - 10 - 15 - 20
 0 - 10 - 20

2. , , ,

2

3 .

1.

0 3 5 8
10 , .

가) ()

‘ ’ (4) 5 6
, 8 60-75% , 7
가 . 7 0
20% . ‘ ’
가 , .

(Fig. 25, 26, 27).

) ()

‘ ’ 80%
, .
6,7 가 5,8

(Fig. 28, 29, 30).

) ()

‘ ’ , , 5,6 65%
7,8 20%

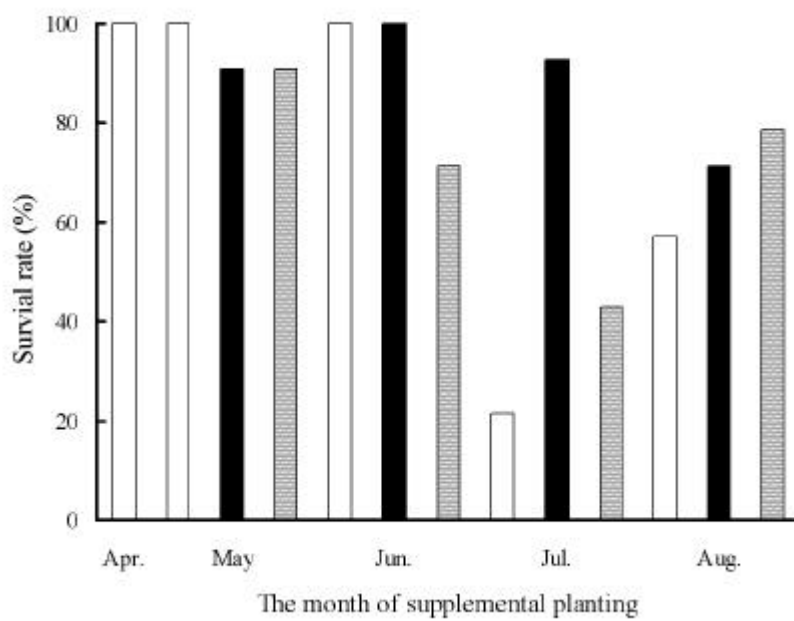


Fig. 25. Survival rate of apple 'Fuji' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

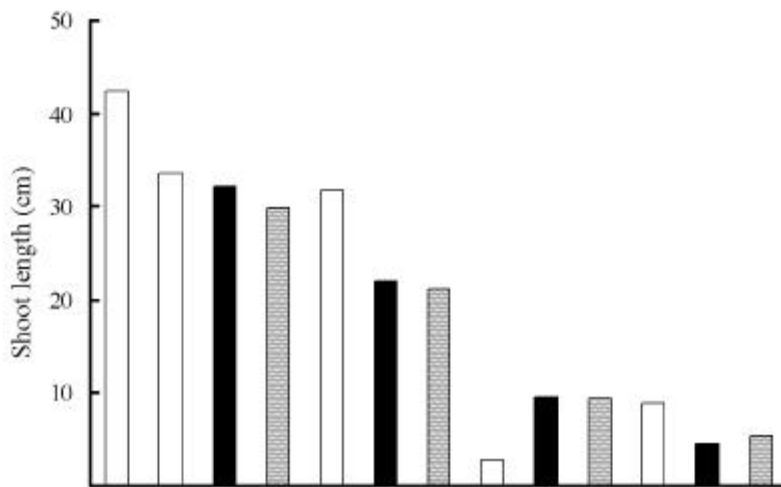


Fig. 26. Final growth of apple 'Fuji' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

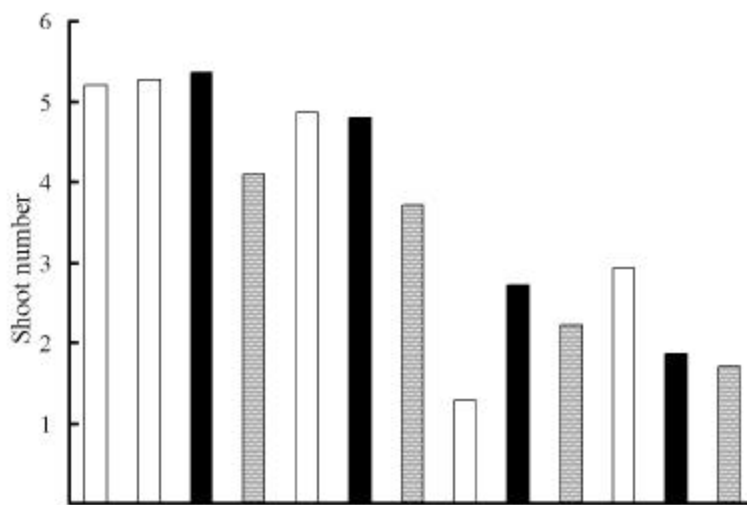


Fig. 27. Final shoot number of apple 'Fuji' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20 °C).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20 °C).

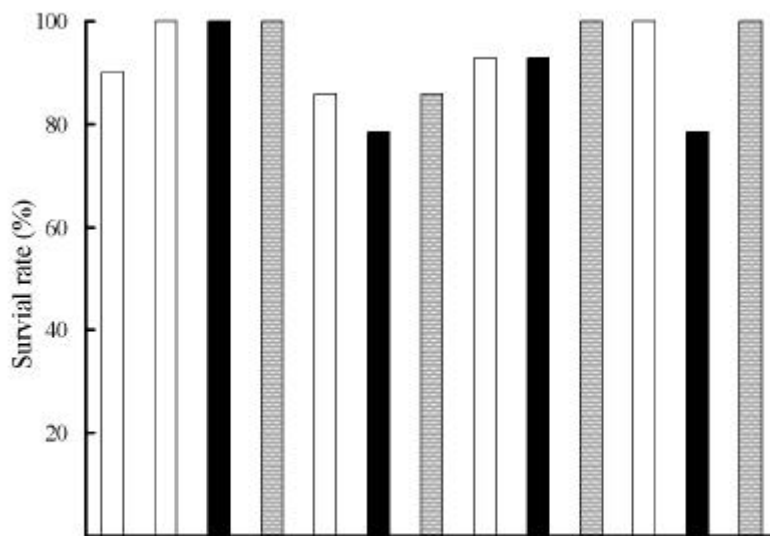


Fig. 28. Survival rate of pear 'Niiitaka' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20 °C).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20 °C).

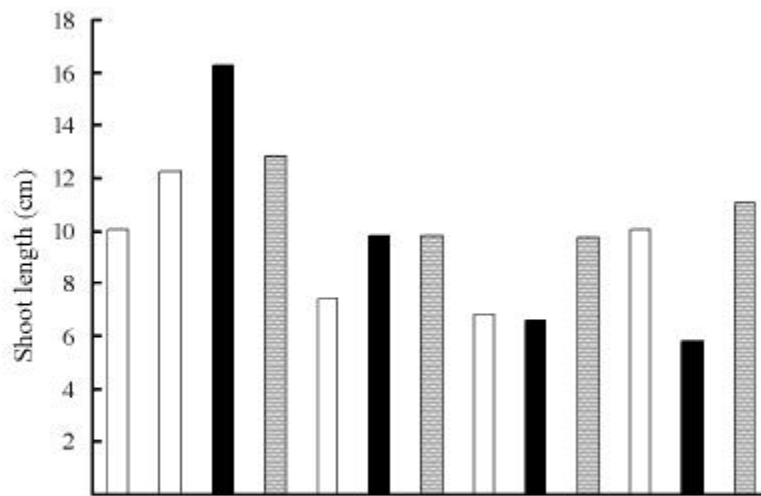


Fig. 29. Final growth of pear 'Niiitaka' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

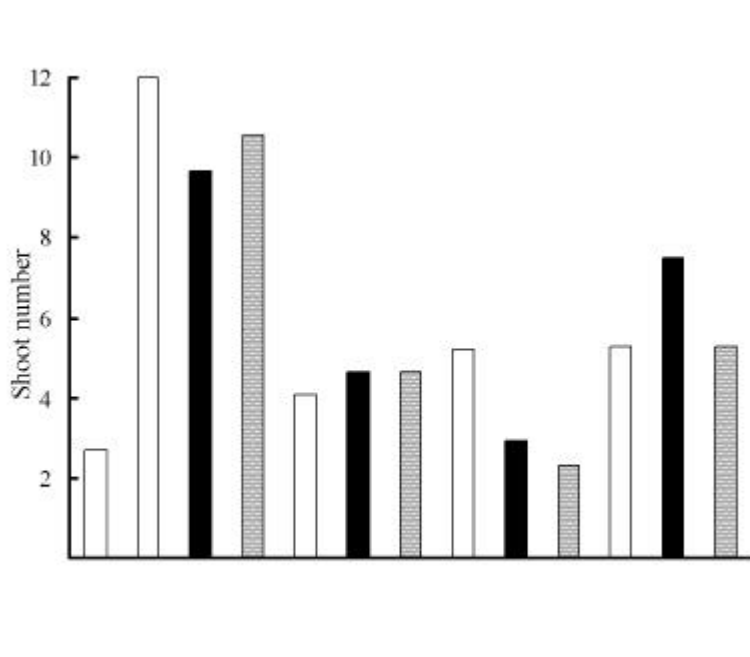


Fig. 30. Final shoot number of pear 'Niiitaka' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

6

7, 8

(Fig. 31, 32, 33).

) ()

‘ ’ 6 8 0 -10 -20

. 7 1

가 , (Fig. 34, 35, 36).

) ()

‘ ’ , 6 0 -5 -10 -15 -20

가 .

가 , 0 -5 -10 -15 -20

0 -10 -20 가

(Fig. 37, 38, 39).

) ()

‘ ’ 5 6 0 -10 -20

가 . 0 -

5 -10 -15 -20

(Fig. 40, 41, 42).

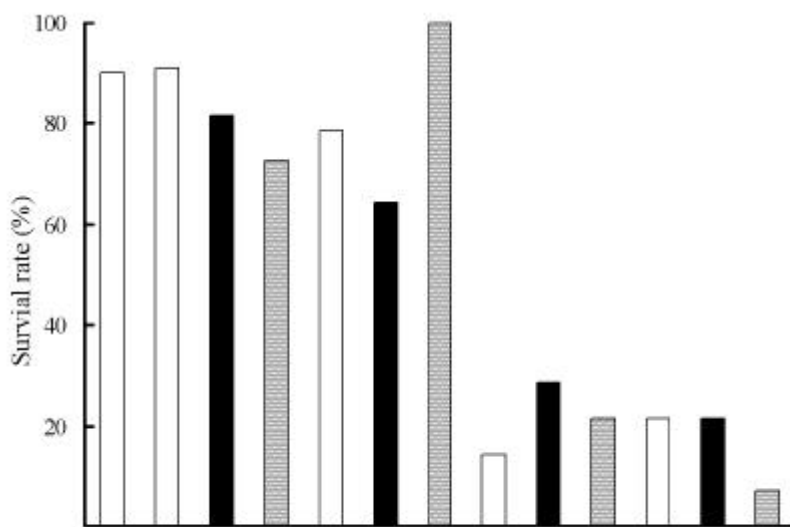


Fig. 31. Survival rate of grape 'Sheridan' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

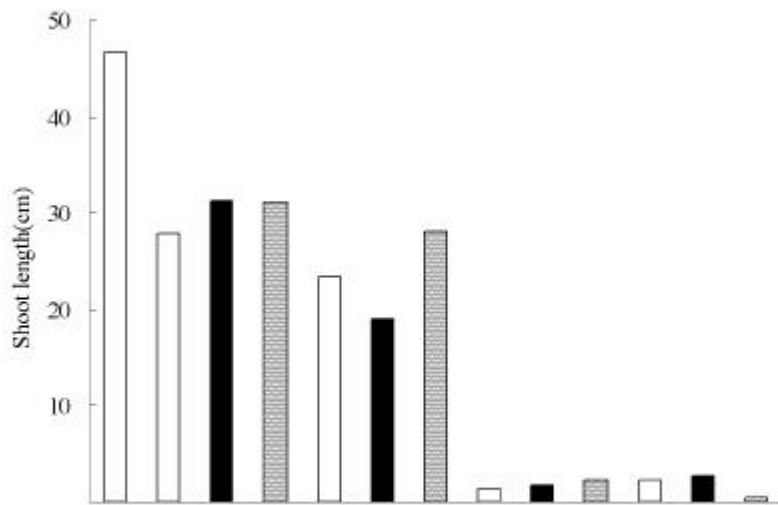


Fig. 32. Final growth of grape 'Sheridan' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

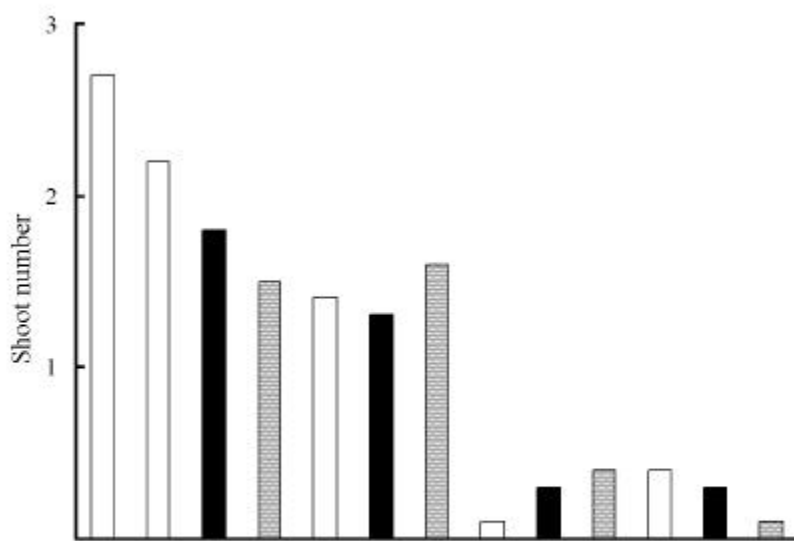


Fig. 33. Final shoot number of grape 'Sheridan' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20 °C).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20 °C).

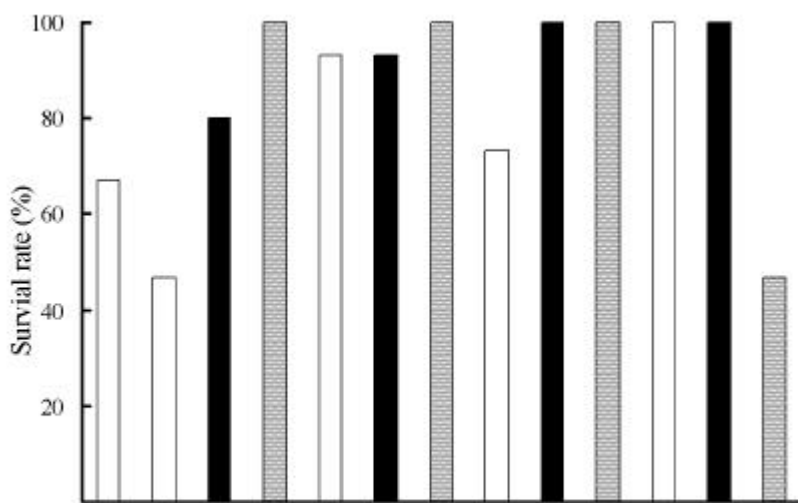


Fig. 34. Survival rate of peach 'Yumyoung' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

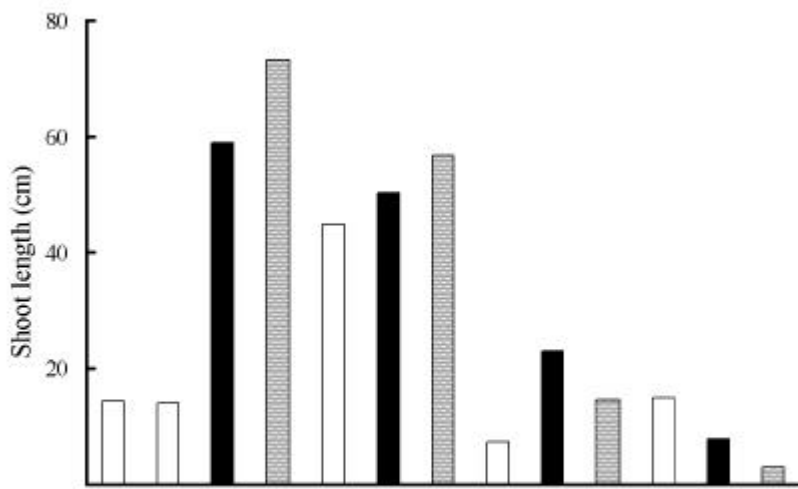


Fig. 35. Final growth of peach 'Yumyoung' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

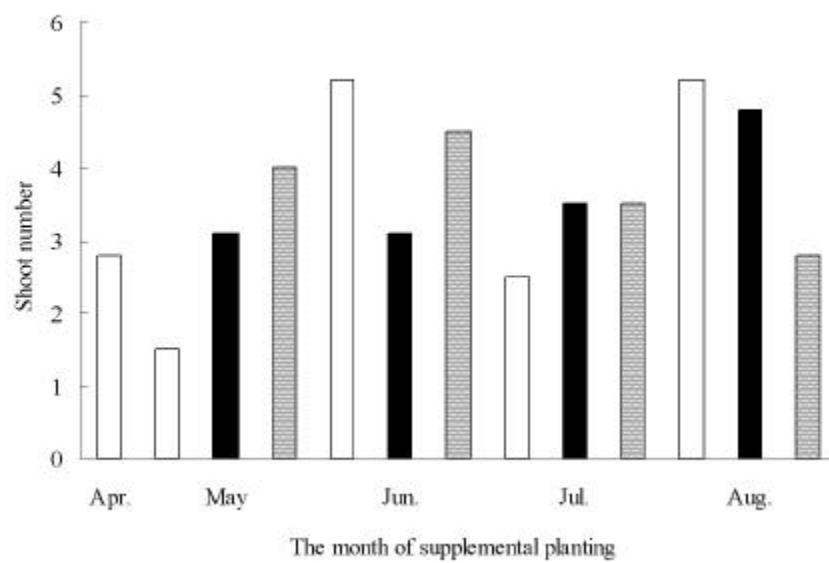


Fig. 36. Final shoot number of peach 'Yumyoung' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20 °C).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20 °C).

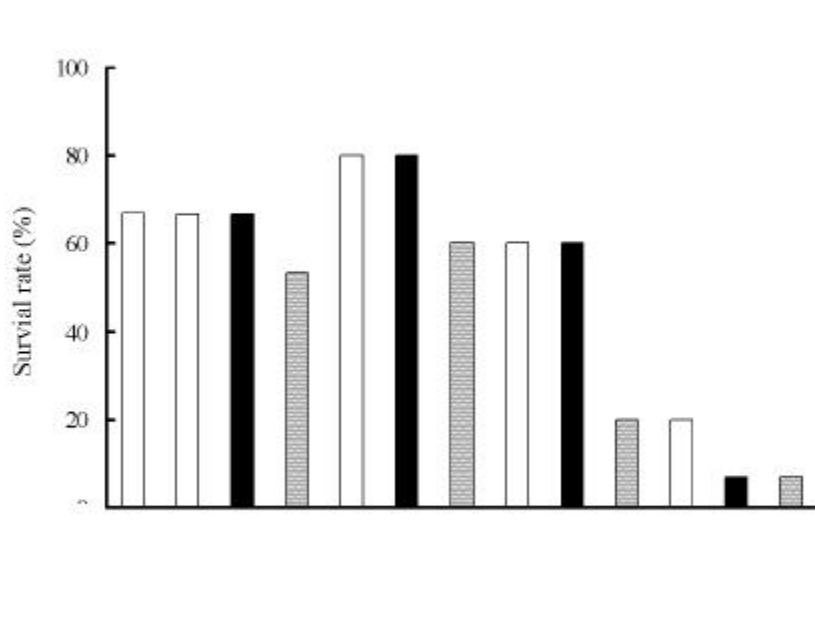


Fig. 37. Survival rate of persimmon 'Fuyu' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

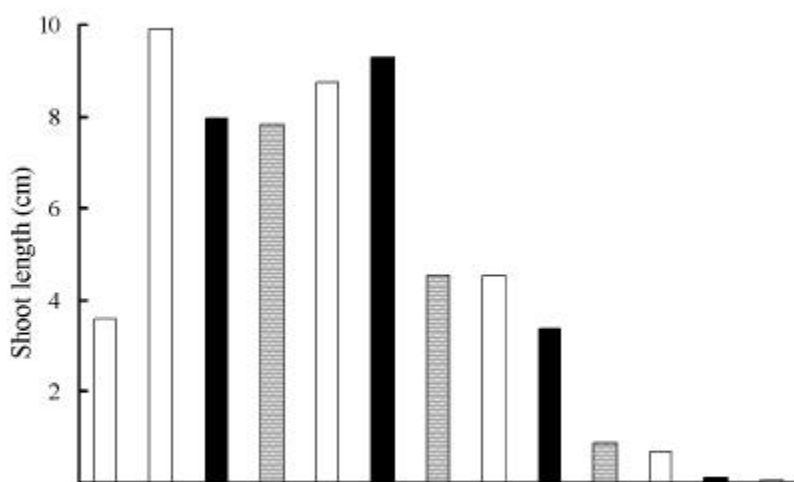


Fig. 38. Final growth of persimmon 'Fuyu' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

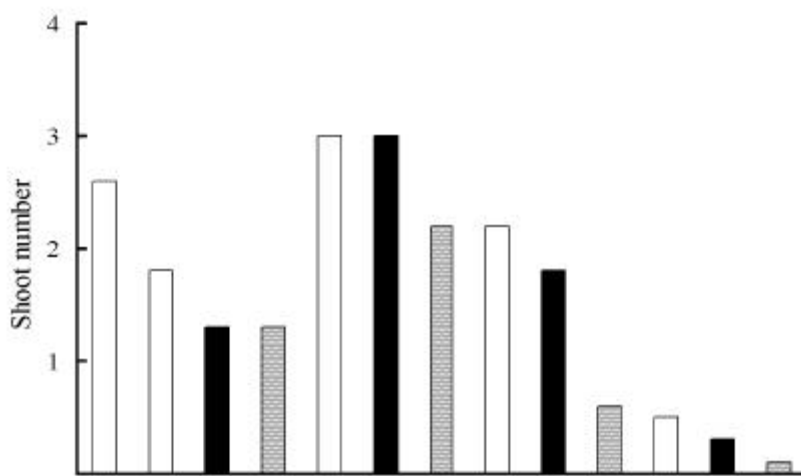


Fig. 39. Final shoot number of persimmon 'Fuyu' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

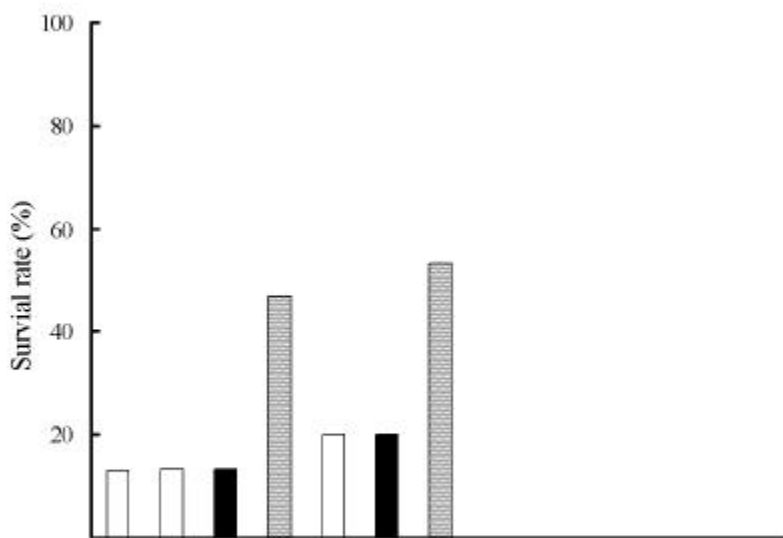


Fig. 40. Survival rate of kiwifruit 'Hayward' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

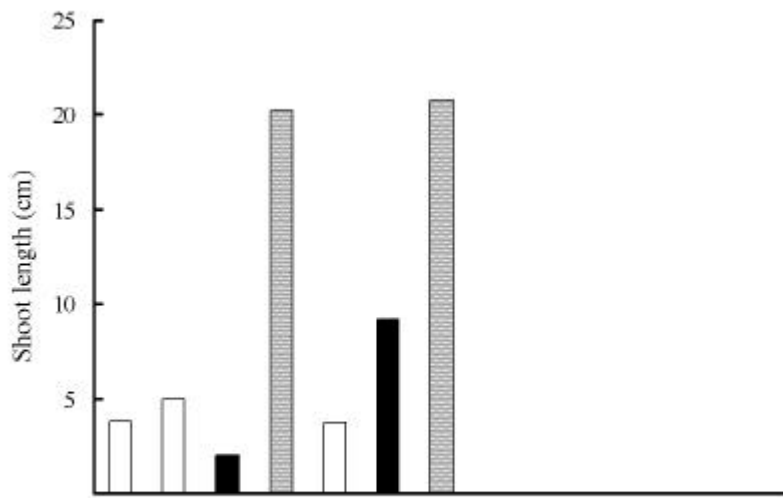


Fig. 41. Final growth of kiwifruit 'Hayward' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

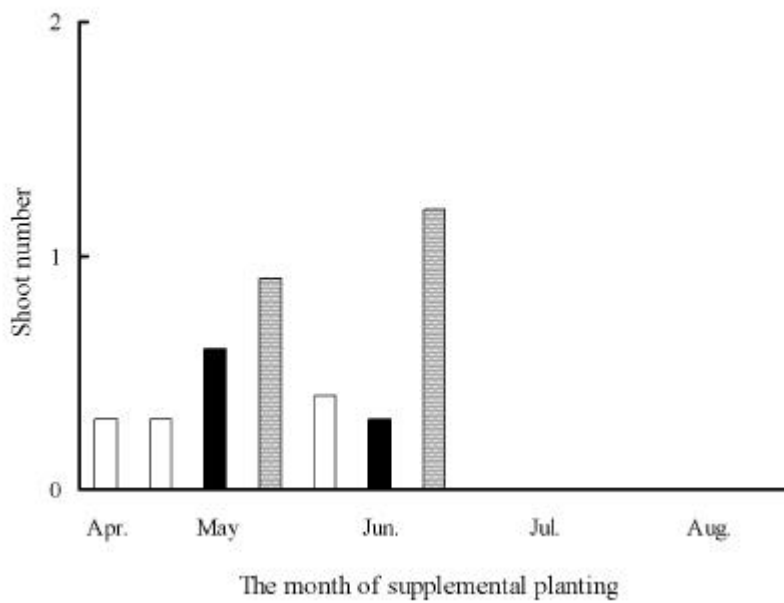


Fig. 42. Final shoot number of kiwifruit 'Hayward' nursery stock by supplemental planting method.

- Fruit nursery stock planted without warming treatment.
- Fruit nursery stock planted with intermittent warming treatment (0 -5 -10 -15 -20).
- ▨ Fruit nursery stock planted with intermittent warming treatment (0 -10 -20).

2.

N, P, K, Ca, Mg

가

0

(Table 14, 15, 16, 17, 18, 19).

Table 14. Mineral and carbohydrate contents in stem of apple 'Fuji' nursery stock by supplemental planting method.

Month	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
4	0.815	0.103	0.630	0.733	0.097	8.5
5	0.803	0.101	0.624	0.725	0.094	8.4
5z	0.799	0.097	0.617	0.720	0.091	8.0
5y	0.780	0.099	0.615	0.715	0.090	7.9
6	0.794	0.098	0.620	0.716	0.092	8.2
6z	0.784	0.094	0.611	0.710	0.088	7.9
6y	0.777	0.092	0.610	0.708	0.089	7.8
7	0.785	0.096	0.613	0.710	0.088	8.1
7z	0.775	0.089	0.605	0.702	0.086	7.7
7y	0.768	0.088	0.603	0.700	0.084	7.5
8	0.771	0.092	0.609	0.692	0.087	7.8
8z	0.763	0.082	0.602	0.688	0.085	7.6
8y	0.758	0.083	0.600	0.685	0.084	7.3

z) Fruit nursery stock planted with intermittent warming treatment(0 -5 -10 -15 -20).

y) Fruit nursery stock planted with intermittent warming treatment(0 -10 -20).

Table 15. Mineral and carbohydrate contents in stem of pear 'Nütaka' nursery stock by supplemental planting method.

Month	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
4	0.843az	0.173a	0.720a	0.735a	0.078a	9.5a
5	0.830	0.169	0.697	0.733	0.076	9.3
5z	0.823	0.167	0.680	0.715	0.074	8.9
5y	0.820	0.168	0.675	0.712	0.074	8.8
6	0.818	0.168	0.677	0.720	0.075	9.0
6z	0.814	0.161	0.660	0.711	0.072	8.8
6y	0.812	0.161	0.656	0.708	0.070	8.7
7	0.813	0.163	0.658	0.709	0.074	8.8
7z	0.802	0.157	0.645	0.693	0.070	8.2
7y	0.801	0.155	0.639	0.690	0.069	8.0
8	0.798	0.159	0.635	0.696	0.071	8.4
8z	0.787	0.155	0.621	0.680	0.067	8.0
8y	0.788	0.153	0.620	0.676	0.066	7.9

z) Fruit nursery stock planted with intermittent warming treatment(0 -5 -10 -15 -20).

y) Fruit nursery stock planted with intermittent warming treatment(0 -10 -20).

Table 16. Mineral and carbohydrate contents in stem of grape 'Sheridan' nursery stock by supplemental planting method.

Month	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
4	0.755az	0.203a	0.620a	0.543a	0.100a	7.9a
5	0.734	0.198	0.613	0.538	0.097	7.8
5z	0.718	0.193	0.609	0.531	0.091	7.5
5y	0.714	0.190	0.607	0.529	0.089	7.4
6	0.715	0.191	0.608	0.535	0.092	7.6
6z	0.696	0.186	0.605	0.528	0.087	7.4
6y	0.694	0.184	0.604	0.525	0.085	7.2
7	0.698	0.185	0.600	0.530	0.088	7.5
7z	0.677	0.178	0.595	0.522	0.081	7.1
7y	0.673	0.175	0.593	0.523	0.078	7.0
8	0.674	0.177	0.594	0.526	0.085	7.3
8z	0.651	0.171	0.588	0.520	0.077	6.8
8y	0.654	0.170	0.589	0.516	0.079	6.9

z) Fruit nursery stock planted with intermittent warming treatment(0 -5 -10 -15 -20).

y) Fruit nursery stock planted with intermittent warming treatment(0 -10 -20).

Table 17. Mineral and carbohydrate contents in stem of peach 'Yumyoung' nursery stock by supplemental planting method.

Month	Mineral (%)					Carbohydrate
	N	P	K	Ca	Mg	
4	1.245 ^{az}	0.183 ^a	0.590 ^a	1.023 ^a	0.137 ^a	11.5 ^a
5	1.215	0.177	0.575	1.015	0.132	11.2
5z	1.165	0.170	0.553	1.003	0.124	10.5
5y	1.158	0.168	0.549	1.000	0.121	10.1
6	1.180	0.169	0.550	1.008	0.124	11.0
6z	1.142	0.160	0.533	0.996	0.117	10.3
6y	1.133	0.154	0.528	0.995	0.113	10.0
7	1.153	0.164	0.532	0.998	0.120	10.5
7z	1.111	0.158	0.510	0.987	0.115	10.1
7y	1.102	0.153	0.504	0.983	0.111	10.2
8	1.525	0.155	0.511	0.990	0.113	10.2
8z	1.483	0.146	0.492	0.977	0.105	9.4
8y	1.475	0.147	0.489	0.975	0.103	9.0

z) Fruit nursery stock planted with intermittent warming treatment(0 -5 -10 -15 -20).

y) Fruit nursery stock planted with intermittent warming treatment(0 -10 -20).

Table 18. Mineral and carbohydrate contents in stem of persimmon 'Fuyu' nursery stock by supplemental planting method.

Month	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
4	1.524 ^{az}	0.099 ^a	0.830 ^a	0.613 ^a	0.062 ^a	8.5 ^a
5	1.480	0.098	0.827	0.606	0.060	8.3
5z	1.434	0.091	0.820	0.599	0.055	7.6
5y	1.430	0.087	0.815	0.593	0.051	7.5
6	1.432	0.096	0.822	0.595	0.059	8.0
6z	1.400	0.090	0.817	0.589	0.055	7.4
6y	1.402	0.086	0.813	0.586	0.056	7.0
7	1.385	0.094	0.814	0.588	0.058	7.8
7z	1.345	0.088	0.806	0.580	0.050	7.1
7y	1.344	0.082	0.801	0.575	0.047	6.8
8	1.340	0.090	0.810	0.583	0.055	7.7
8z	1.308	0.085	0.802	0.573	0.046	6.8
8y	1.300	0.081	0.795	0.566	0.044	6.4

z) Fruit nursery stock planted with intermittent warming treatment(0 -5 -10 -15 -20).

y) Fruit nursery stock planted with intermittent warming treatment(0 -10 -20).

Table 19. Mineral and carbohydrate contents in stem of kiwifruit 'Hayward' nursery stock by supplemental planting method.

Month	Mineral (%)					Carbohydrate (%)
	N	P	K	Ca	Mg	
4	0.585az	0.133a	0.440a	0.393a	0.082a	6.9a
5	0.575	0.130	0.428	0.380	0.080	6.7
5z	0.558	0.118	0.421	0.367	0.075	6.4
5y	0.552	0.112	0.419	0.360	0.072	6.4
6	0.561	0.128	0.414	0.365	0.079	6.6
6z	0.550	0.119	0.405	0.343	0.073	6.1
6y	0.541	0.114	0.397	0.337	0.068	6.0
7	0.545	0.124	0.400	0.355	0.074	6.3
7z	0.532	0.116	0.381	0.332	0.066	5.6
7y	0.526	0.113	0.377	0.324	0.061	5.5
8	0.536	0.122	0.389	0.346	0.074	6.3
8z	0.522	0.108	0.378	0.328	0.064	5.2
8y	0.517	0.104	0.373	0.326	0.063	5.2

z) Fruit nursery stock planted with intermittent warming treatment(0 -5 -10 -15 -20).

y) Fruit nursery stock planted with intermittent warming treatment(0 -10 -20).

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