supplemented by sprinkler irrigation when necessary.

The crops were harvested the first week of May both years, by severing plants at the soil surface. Just before harvest, plants of the 2nd crop damaged by winter cold were counted. Half the area of each plot and all the area in each plot was harvested the 1st and 2nd crops, respectively.

The 1st crop experienced severe cold to -26°C, but always with snow cover when below -16° (Fig. 2). Other short periods of fairly low temp occurred without snow cover but daily minimum temp (DMT) was -12°C or higher. No winter damage was observed in any plot the next spring. Total yields ranged from 6.3 to 9.6 MT/ha with no significant difference among fertilizer treatments (Table 1).

The 2nd-year crop experienced 5 brief periods of severe cold, 2 with no snow cover and with DMT as low as -22°C (Fig. 3), including DMT of -11° or less for 8 consecutive days in early Feb. Total yields of spinach ranged from 8.8 to 11.3 MT/ha (Table 1) again with no significant differences among soil fertility treatments. All plots contained some dead, chlorotic, or dwarfed plants but differences in the no. of cold-damaged plants were not significant.

Plants of both crops appeared visually to have resumed normal growth approx March 7 (Fig. 2, 3) when DMT were at or above -8°C. Temperature curves for both years were similar for early March (Fig. 2, 3), so the compensation point in spinach may be at a DMT of approx -8°. Harvest was the first week in May, approx 3 weeks earlier than that of spring-planted crops in the same area (4, 8).

Table 1. Total yield of fall-planted compared to spring-planted spinach.

Fertilizer treatment	Rate (MT/ha)	Yield (MT/ha) Fall crop 1970[z]	Fall crop 1971[y]	Spring crop 1970[x]	Spring crop 1971[w]
Control	–	7.67	8.80	6.24	7.45
Organic (Feedlot manure)	22.4	6.77	9.50	7.53	8.74
	44.8	7.18	9.29	8.77	8.85
	67.2	6.27	9.16	9.19	6.51
	89.6	7.64	9.13	8.99	8.67
Mineral (Nutrient equivalent to manure)	22.4	7.17	9.79	9.96	10.17
	44.8	9.41	11.34	9.40	13.51
	67.2	9.23	9.92	7.95	13.42
	89.6	8.17	10.34	5.77	11.74
(Split N: nutrient equivalent to manure)	22.4	9.58	10.56	10.40	12.78
	44.8	9.27	7.98	8.63	12.58
	67.2	9.01	10.04	7.35	12.92
	89.6	9.36	11.24	7.83	15.50
LSD 5%		NS	NS	.31	.53
Seasonal mean		8.21	9.78	8.31	10.99

[z]Planted Sept. 25, 1970; harvested May 3, 1971.
[y]Planted Sept. 1, 1971; harvested May 5, 1972.
[x]Planted April 7, 1970; harvested May 16, 1970.
[w]Planted April 21, 1971; harvested June 8, 1971.

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Rapid Vegetative Propagation of Asparagus through Lateral Bud Culture[1]

Hsu-Jen Yang and W. J. Clore[2]
Washington State University,
Irrigated Agriculture Research and Extension Center, Prosser

Abstract. **A modified procedure was developed for vegetatively increasing normal diploid *Asparagus officinalis* L. This is accomplished by culturing stock plants from unrooted lateral buds from spears, and by rooting buds from basal portions of shoots of stock plants. Murashige and Skoog's inorganic medium with added growth substances was used.**

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[2]Research Associate and Horticulturist, respectively, Department of Horticulture.

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Many workers have searched for a practical technique for vegetative mass production of asparagus from somatic cells and organ cultures (1, 2, 6, 7, 8, 9). Complete plants have been obtained by cell and callus culture, but most were tetraploid and involved aneuploid cells (4, 8). Recently, Murashige, et al. (6) and Hasegawa, et al. (3) reported that normal plants could be obtained by shoot apex culture. We also describe a procedure that avoids callus formation 1) in establishing aseptic stock plants from lateral buds of asparagus spears, 2) in producing rooted plantlets from the buds of stem segments of the stock plants.

The nutrient media which we used contained: inorganic salts according to Murashige and Skoog (5), 3% sugar, 0.7% agar, 2 ppm glycine, 100 ppm myo-inositol, 0.5 ppm nicotinic acid, 0.5 ppm pyridoxine•HCl, and 0.1 ppm thiamine•HCl. NAA (α-naphthalene acetic acid) and kinetin were added separately and in various combinations in the following concentrations: NAA-0.0, 0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, and kinetin-0.0, 0.01, 0.05, 0.1, 0.2, 0.3 ppm.

The media were adjusted to pH 5.7 with either 1N NaOH or 1N HCl. The media were autoclaved at 6.8 Kg for 15 min at 121°C. The cultures were maintained at 27 ± 1°C under 16 hr of 100 ft-c of light daily from 20-W Gro-Lux fluorescent lamps.

Production of stock plants. Selected male plants of the *Asparagus officinalis* L. 'University of California 500W' selection were taken from field plantings. Spears 15 to 20 cm long were obtained from the selected plants. The apical 2 cm of each spear was removed.

The lateral buds on the subjacent 5 cm section were used as a source of explants. The outermost scale of the lateral buds was removed, and the surface of the section was sterilized with 10% commercial Clorox (0.525% sodium hypochlorite) for 15 min followed by 3 rinses with sterile distilled water. Buds were excised and placed in 10 x 2.5 cm pyrex test tubes containing 5 ml of media with or without NAA and kinetin. After 4 weeks, shoots from buds were well-developed in media with 0.05 to 0.1 ppm of NAA. When the shoot reached 8 to 10 cm, it was excised and cut into 1 bud segments. Two or 3 segments were cultured per 125 ml Erlenmeyer flask on 50 ml of media with 0.05 to 0.1 ppm of NAA and kinetin. After 4 to 6 weeks, when multiple shoots developed from the buds, the plantlets with only shoots were transferred to another flask to promote growth of shoots. These became the stock plants and were maintained by repeated transfer to fresh medium containing 0.1 ppm of NAA and kinetin after each harvest of shoots.

Clone increase. From the stock plants, vigorous shoots about 15 cm long, 1 mm in diam, and bearing 10 to 20 buds were used as the source of explants for increasing the clones. The shoots were divided in thirds—apical, middle, and basal. Each portion was cut into segments each about 6 mm in length bearing 1 bud in the center, and the identity of all segments was maintained to determine whether differences in response existed. Four segments were placed horizontally in a flask containing 50 ml of medium with 0.1 ppm of NAA and kinetin. After 3 months of culturing, we found significant differences in shoot and root production among the buds from the apical, middle, and basal portions of stock plant shoots (Table 1). The greatest success (96.7% plantlets but with only shoots) was obtained from basal buds. These plantlets also rooted most readily (62.2%), and were more vigorous than those from buds from the apical and middle portions (Fig. 1). Thus, culturing buds from the basal portion of shoots is recommended.

Shoot growth and root initiation from buds from the basal portion of shoots were influenced by NAA and kinetin concn (Table 2). Plantlets with multiple shoots developed on media with low NAA and kinetin with little or no callus formation or root initiation. Short shoots, proliferating callus, and roots initiated from the callus mass or from the base of the buds were observed on media with high NAA (>0.3 ppm) and kinetin (>0.1 ppm). Plantlets with vigorous multiple shoots and large, white roots developed on the media containing 0.1 - 0.3 ppm of NAA and 0.1 ppm of kinetin. No marked differences in root initiation were observed in the media containing 0.1, 0.2, and 0.3 ppm of NAA and 0.1 ppm of kinetin, but more active callus formation was observed with 0.3 ppm of NAA, with shoot growth from buds inhibited. This resulted in a decrease in survival. Thus, a nutrient medium containing 0.1 - 0.2 ppm of NAA and 0.1 ppm of kinetin is suitable for propagation.

About 50% of plantlets in surviving cultures had well-developed shoots and

Table 1. Growing and rooting ability of buds from different portions of the asparagus shoot after 3 months in culture. (Means range from 30-45 shoots).

Bud position on shoot	Plantlets with shoot (%)	Plantlets with shoot and root (%)
Apical	59.2 a[z]	11.7 a
Middle	71.1 b	26.9 b
Basal	96.7 c	62.2 c

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

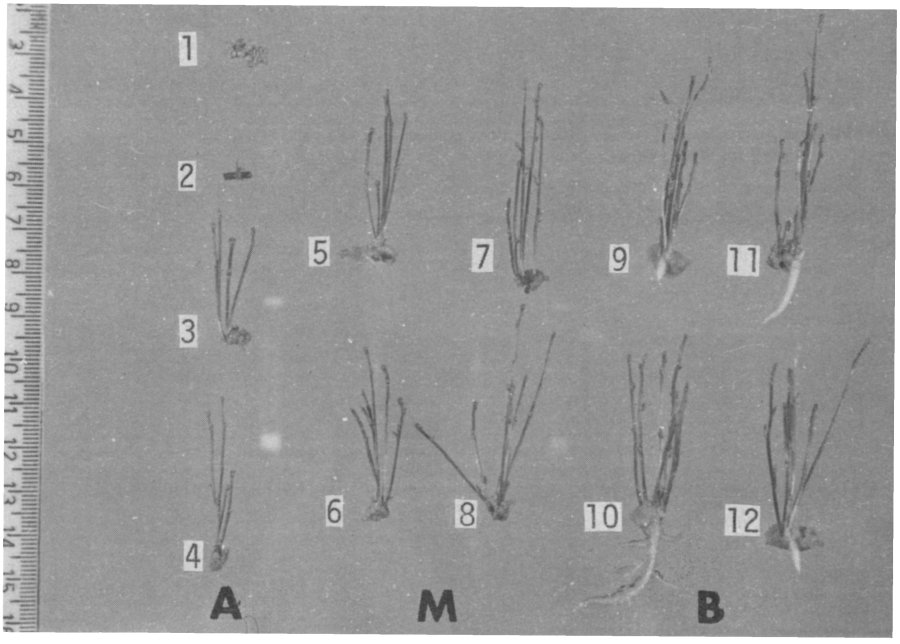

Fig. 1. The development of shoot growth and rooting of buds by positions: apical portion (A, 1-4), mid-portion (M, 5-8), and basal portion (B, 9-12). Numbers indicate the 12 buds from apex to base of shoot.

Table 2. Effect of NAA and kinetin on shoot (S) growth and root (R) initiation from asparagus shoot buds after 10 weeks in culture.[z]

Kinetin (ppm)		NAA (ppm) 0	0.01	0.05	0.1	0.3	0.5
0	S	++	++	++	+++	++	+
	R	–	–	–	+	+	+
0.01	S	++	++	++	+++	++	+
	R	–	–	–	+	+	+
0.05	S	++	++	+++	+++	++	+
	R	–	–	+	++	++	++
0.1	S	++	++	+++	+++	++	+
	R	–	–	+	+++	+++	++
0.3	S	++	++	+++	+++	++	+
	R	–	–	–	+	+	+

[z] = none; + = low; ++ = medium; +++ = high.

roots. When recultured in media containing 0.05 - 0.1 ppm of NAA and 0.0 - 0.05 ppm of kinetin, 50% of the remaining plantlets were induced to root and developed into acceptable complete plantlets.

When the roots began to elongate, plantlets were recultured individually in flasks in the medium alone, or in a medium containing 0.01 ppm of NAA. When the roots elongated to about 8 cm, plantlets were transferred to unglazed pots containing a 2:1:1 sterilized mixture of sandy loam, peat, and sand. Each pot was covered with 10 x 31 cm plastic (0.076 mm thickness) bag to assist plantlet acclimation to a 27°C glasshouse environment. About 80% of the plants survived.

Cytological studies. Root tips and flower buds were used for cytological examinations. The root tips were pre-treated with 0.002M 8-hydroxyquinolin for 1 hr. The tissue were fixed in alcohol-acetic acid solution (3:1) for 2 hr at room temp. The aceto-carmine smear and Feulgen squash techniques were used to make chromosome counts. Cytological examination showed that all the plants obtained from stem segments cultures were diploid, 2n=20. No polyploid plants were found, indicating this propagation method effectively maintains the normal diploid chromosome number.

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CULTIVAR RELEASES

'Eden' Peach[1]

Robert C. Lamb[2]

New York State Agricultural Experiment Station, Geneva

'Eden', a white-fleshed, freestone peach [*Prunus persica* (L.) Batsch.] with high productivity and good quality was released in Sept. 1972. It was named for a town in Erie County, N. Y.

Origin

'Eden' was selected in 1949 from a progeny of 9 seedlings of 'Champion' x 'Raritan Rose'. The cross was made in 1940 by Professor Richard Wellington and tested as N. Y. 1466. It was distributed by the New York State Fruit Testing Cooperative Association, Inc., Geneva, from 1961-1966.

Description

The tree of 'Eden' is rather vigorous and very productive. Blossom buds are slightly less resistant to low temperatures than are those of 'Redhaven' and 'Triogem' (Table 1). The chilling requirement is similar to that of 'Redhaven'. Leaf glands are reniform. The blossoms are nonshowy and small. 'Eden' is not resistant to perennial canker, but appears to be rather tolerant; at least trees with cankers do not die as a result of it.

The fruit of 'Eden' ripens August 25th on the average at Geneva, N. Y., about 7 days after 'Redhaven' and 'Raritan Rose' or 5 days before 'Redrose'. 'Eden' is medium to large, in size averaging 6.7 cm (2.7 inches) in diam, and roundish in shape. It is 60% covered with bright red over creamy white ground color and is quite attractive. The skin is thin, medium tough and adherent, with dense, short pubescence.

'Eden' has nearly smooth textured, moderately firm, flesh which is creamy white with a little red at the pit. Flavor is sweet and rich. The canned product is satisfactory although the flesh browns quickly on exposure to air. The pit is free, small, nearly oval in shape, and the surface is corrugated and pitted.

Availability

Limited numbers of trees of 'Eden' will be available in the Fall of 1973 through the New York State Fruit Testing Cooperative Association, Inc., Geneva. Dormant scions and budwood are available from the same organization.

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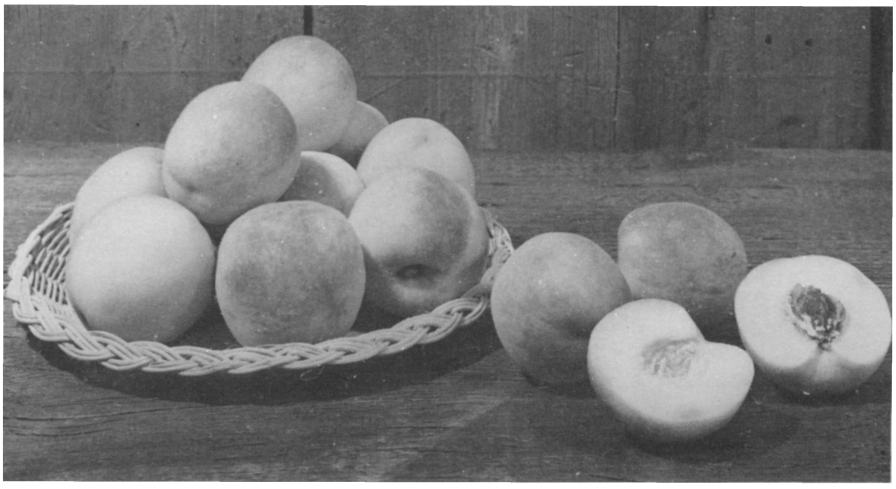
[2]Department of Pomology and Viticulture.

Table 1. Blossom bud survival of 'Eden' as compared to other cultivars, Geneva, N.Y.

Cultivar	Blossom bud survival (%)							
	1961	1962	1963	1965	1966	1970	1972	Avg.
Brighton	7	3	7	42	58	83	59	37
Eden	30	19	59	50	69	84	59	53
Redhaven	58	17	47	88	83	72	84	64
Triogem	80	16	37	43	78	86	69	57



'Eden' peach