Table 1. Mean soluble solids associated with various density classes in carrot roots.

Cultivar and (source)	Location[z]	Specific gravity	No. of roots	Mean soluble solids
Nantes Coreless (Park)	Z	>1.030	12	7.85 a[y]
		1.026–0.030	26	7.59 a
		<1.026	25	7.05 b
Nantes Coreless (Park)	S	>1.028	26	7.10 a
		<1.028	42	6.80 b
Scarlet Nantes (Harris)	Z	>1.030	19	7.84 a
		1.026–1.030	32	7.30 b
		<1.026	28	7.13 b
Scarlet Nantes (Harris)	S	>1.028	33	7.12 a
		<1.028	55	6.31 b
Tantal (Clause)	Z	>1.030	17	8.05 a
		1.026–1.030	23	7.60 b
		<1.026	48	6.89 c
Tantal (Clause)	S	>1.028	12	7.69 a
		<1.028	24	6.97 b
Danvers 126 (Keystone)	Z	>1.030	7	8.38 a
		1.026–1.030	20	7.29 b
		<1.026	20	6.99 b
Danvers 126 (Keystone)	S	>1.028	8	8.30 a
		<1.028	29	7.68 b
D 301 (Dessert)	Z	>1.034	89	9.78 a
		1.030–1.034	28	9.05 b
		<1.030	15	8.27 c
Hicolor 9 (Asgrow)	S	>1.028	96	7.88 a
		<1.028	99	7.16 b
Tip-top (Sluis & Groot)	S	>1.028	23	7.22 a
		<1.028	42	6.82 b

[z]Z=Zellwood (organic soil); S=Sanford (Leon fine sand).

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

were tested in solutions with sp gr of 1.026 and 1.030 to obtain a 3-part separation of the sample. The only exception was for the breeding line D 301, which was tested at sp gr of 1.030 and 1.034 because it was known to have a very high SS level.

After the roots of each cultivar were separated into density classes, the SS of each root was determined by methods previously described (1). The differences between mean SS of contiguous density classes ranged from 0.17 to 1.09 with an average difference of 0.57 (Table 1). Most of these values were statistically significant.

The roots were subsequently held in cold storage for 10 weeks and planted for seed production. There appeared to be no root injury as a result of exposure to the brine for 1 or 2 min.

This method is rapid, simple, and useful to carrot breeders. Any open-pollinated line can be screened rapidly for high density roots. Subsequent refractive index measurement of these roots will yield a higher proportion of high SS selections than unselected roots. For example, the 96 'Hicolor 9' roots in Table 1 with sp gr over 1.028 had 13 roots with over 8.5% SS, while only 6 roots out of 99 in the sp gr class under 1.028 had over 8.5% SS. Another use might be to maintain high SS inbreds or mass selections for high SS without refractive index measurement. For example, D 301, which is a high SS inbred, had 32 out of 43 roots with less than 9.1% SS in the sp gr classes below 1.034. There were only 6 out of 89 roots with less than 9.1% SS in the sp gr class above 1.034. Hence, selection for high density removed the majority of roots with low SS from the root sample to be used for seed production.

It was frequently observed that the largest roots in each test had low density. Although no measurement was made of this variation, it appears that high density roots may be smaller on the average than low density roots. Repeated selection for high density may significantly affect the average root size of a population.

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Seasonal Mineral Accumulation by the Sweet Potato[1]

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Abstract. **The concentration and total content of P, K, Ca, Mg, N, Fe, Mn, and B in storage roots and in vines of sweet potatoes [*Ipomoea batatas* (L.) Lam.] was followed for a 14 week period beginning 2 months after planting. The concentration of N, P, K, Mn, and Mg in the vines and N, P, and K in the roots decreased slightly during the period. Other elements showed no definite seasonal trends. Total uptake by the vines showed little change after the second sampling period except for Ca and Fe. N and Mn content of the vines decreased toward the latter part of the season. The roots showed increasing total accumulation of all elements as the crop developed. Although there were differences among cultivars they were not of sufficient magnitude to suggest substantial differences in mineral requirements.**

The cultivars of sweet potatoes grown and the fertilization practices employed have changed greatly since early studies on mineral uptake by sweet potatoes were reported (1, 2). The objective of this experiment was to study the seasonal uptake and concn of the several nutrient elements in relation to the growth of the sweet potato plant. Data are reported here on the concn of the several elements in vines and roots of the crop and the accumulation or content at bi-weekly intervals during the period of root development.

'Centennial', 'Jewel', 'Nemagold', and 'Redmar' sweet potatoes were grown in 1971 on a Norfolk sandy loam near Salisbury, Maryland. Fertilization consisted of 1680 kg per ha of a 5–4.4–16.6–1.2 (N–P–K–Mg) analysis applied 1/3 preplant broadcast and 2/3 in 2 topdress applications. The soil type and fertilization program are typical of commercial sweet potato production in Maryland. Rainfall was adequate during the entire season. Sprouts were planted on May 24, spaced 31 cm apart in 93 cm rows, resulting in about 36,000 plants per ha. Sampling was begun on July 27, at which time storage roots were large enough to provide adequate material for analysis. Subsequent sampling was done at 2-week intervals, with the last sampling

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on Oct. 21. Plots of each cultivar consisting of 5 adjacent plants in each of 4 field blocks, were removed at each sampling. To avoid disturbance to subsequent samples, guard rows and plants were left at each date of sampling. The vines were weighed and the dry wt per plant determined by drying an aliquot. All storage roots of 1.37 cm diam or greater were weighed, and the dry wt determined by drying an aliquot. No attempt was made to sample the fibrous root systems.

N was determined by semi-micro Kjeldahl, K by flame photometry, P by a molybdate colorimetric procedure, B by the curcumin method, and Ca, Mn, Mg and Fe by a Model 303 Perkin Elmer atomic absorption spectrophotometer. Samples were ashed at 525°C and the ash dissolved in 1 reagent HCl:1 H_2O (v/v).

The dry wt of the vines increased only slightly after the 2nd sampling date, but root growth continued throughout the sampling period (Table 1). All cultivars produced a good yield by the last sampling date (avg 44,500 kg/ha). At the later sampling dates some of the older leaves had abscised, accounting in part for the lack of increase in vine dry wt, even though vine growth was apparently vigorous throughout.

Table 1. Dry matter wt of sweet potato cultivars at intervals during root development period.

Cultivar	Dry matter (g/plant) July 27	Aug. 11	Aug. 25	Sept. 6	Sept. 22	Oct. 6	Oct. 21
				Vines			
Centennial	51	79	86	97	107	106	97
Nemagold	38	73	86	113	116	116	124
Redmar	42	83	82	84	86	66	74
Jewel	47	79	82	103	104	105	91
Avg	45	79	84	99	103	98	97
				Roots			
Centennial	24	75	142	179	318	313	300
Nemagold	24	50	107	153	202	224	250
Redmar	35	87	166	205	253	232	319
Jewel	40	88	147	220	254	306	323
Avg	31	75	141	189	257	269	298

Elemental concn. Although statistically significant differences exist among cultivars (Table 2), the magnitude of difference is not considered sufficiently great as to invalidate the use of the mean values. Furthermore, the trend in concn of the several elements over the sampling period was similar for cultivars. The significant cultivar × date interactions found were of magnitude rather than reversal in nature. For these reasons the mean values of elemental concn for the 4 cultivars are presented in Fig. 1.

The concns of N, P, and K in the roots showed a seasonal decline, that of the other elements remained quite stable. In the vines the concn of N, P, K, Mn, and Mg declined during the sampling period. Following a decline during the first 3 samplings, Ca tended to increase slightly toward the end of the period. With all elements, the concn in the vines exceeded that in the roots, and with the exception of P and K, by several-fold.

Elemental accumulation. Mineral content of the roots increased as the

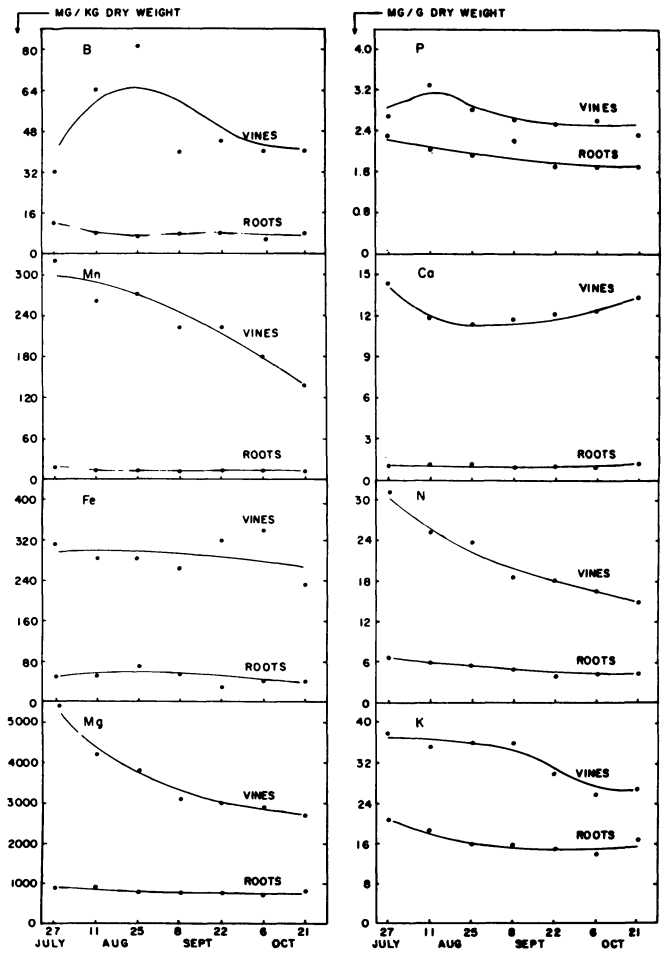

Fig. 1. Concn of the several elements in sweet potato vines and roots at each sampling date.

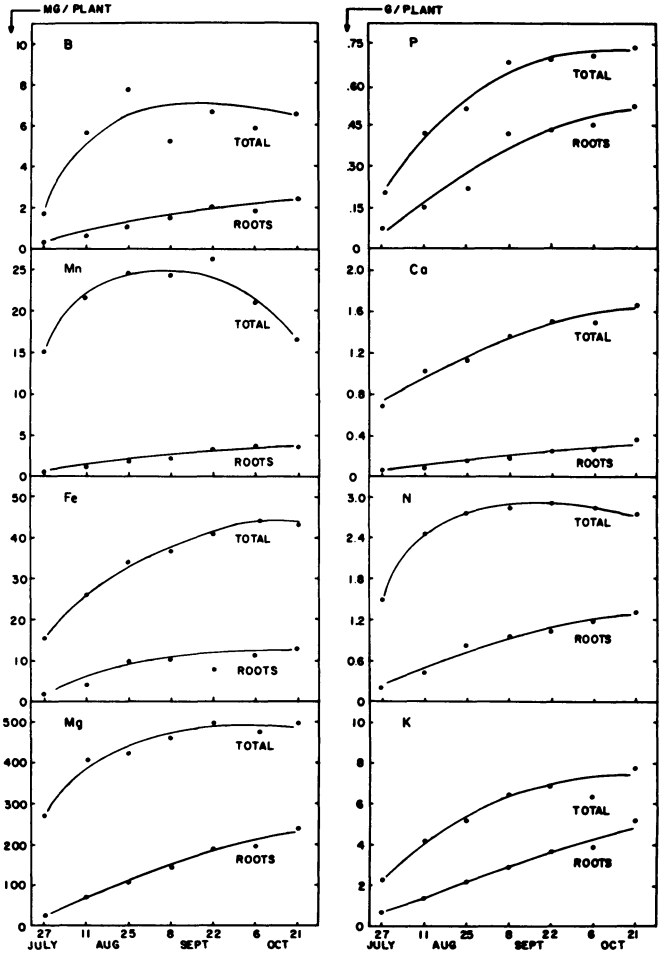

Fig. 2. Accumulation of the several elements in sweet potato roots and total uptake at each sampling date.

Table 2. Concn of elements in sweet potato vines and roots.[z]

Cultivar	(mg/g dry wt basis) N	P	K	Ca	Mg	(mg/kg dry wt basis) Fe	Mn	B
				Vines				
Centennial	20.5b[y]	2.9a	33.9a	14.6a	4.3a	256b	269a	49a
Jewel	22.5a	2.9a	33.7a	13.2b	3.6b	272b	231b	51a
Nemagold	19.7c	2.6b	29.1b	10.2d	2.7c	324a	201c	49a
Redmar	22.5a	2.4c	33.3a	11.5c	3.7b	289ab	221b	45a
Avg	21.6	2.7	32.5	12.4	3.6	285	253	49
				Roots				
Centennial	5.5a	2.0a	17.4a	0.9b	0.8a	40c	12c	8a
Jewel	5.6a	1.8b	15.9a	1.1a	0.8a	54ab	13b	9a
Nemagold	5.4a	2.1a	16.6a	00.8b	0.9a	42c	15a	8a
Redmar	4.7b	1.8b	17.0a	0.9b	0.8a	59a	13b	8a
Avg	5.3	1.9	16.7	0.9	0.8	49	13	8

[z]Values are means of 7 analyses made at 2 week intervals from July 27 to harvest date on Oct. 21.

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

crop developed; the increase in dry wt more than offset any decrease in concn of the element (Fig. 2). With the exception of Mn, from 42 to 74% of the total accumulation of elements occurred during root development. The elemental content of the vines decreased in most instances after the 2nd or 3rd sampling date because of the failure of dry wt increase of the vines and lower concn of nutrients at the later dates. As a consequence total elemental content of the plants showed little change in the latter part of the season, with the fraction found in the roots forming an ever increasing % of the total (Table 3).

Table 3. Content of the several elements in sweet potato roots at each of 3 sampling dates.

Element	% of total plant uptake, Sampling date: July 27	Sept. 8	Oct. 21
N	13	33	48
P	37	62	71
K	30	45	67
Ca	4	13	17
Mg	10	31	49
Fe	11	28	30
Mn	3	9	20
B	18	29	37

Of the 4 elements supplied in the fertilizer program, the uptake per plant of 2.75 g N, 7.80 g K, and 0.50 g Mg, was quite similar to the amount supplied per plant 2.61, 7.70 and 0.61 g, respectively, suggesting that the amount applied was sufficient to grow the crop. The amount of P supplied was about 3 x that utilized in plant growth.

Soil analyses of the Norfolk sandy loams used for sweet potato production in Maryland typically show "low" to "medium" values for K and Mg and "very high" values for P. Our data point out the necessity of maintaining adequate levels of readily leached nutrients such as N, K, and Mg during crop development. The data also emphasize the over-use of P on these soils.

The seasonal trends in concn of N, P, and K in the vines and roots are similar for 'Maryland Golden' (2). The relative accumulation was also comparable in the earlier study, although the total uptake was greater due to a larger crop. The nutrient requirements for a given crop yield are similar for the cultivars of sweet potatoes used in this study.

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Improving the Survival of Aseptically-cultured Asparagus Plants in Transplanting[1]

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Abstract. **Survival of *Asparagus officinalis* L. transplants in soil was significantly improved with a minimum of labor when they were first transplanted into the Jiffy 7 peat pots from aseptic culture and grown under intermittent mist for 5 to 8 days.**

Failure occurs in transplanting aseptically-cultured asparagus plants into soil (1, 4). Techniques of subculturing or reculturing plants on auxin-free medium (1, 2, 3, 5), and under high light intensity (3) to produce transplantable plants have been developed. Recently, we reported about 70% survival transplants without a sub- or re-culture procedure after root formation when each potted plant was covered with a plastic bag to prevent plant desiccation at the initial stage of transplanting (6). During the first 2 to 3 weeks after transplanting, it may be necessary to remove and replace each bag to examine or water the plants. This work is too time consuming for commercial application. Furthermore, a higher survival rate of plants is required for a commercial operation. This paper reports a technique for improving the survival rate of aseptic asparagus transplants.

Complete plants of 'University of California (UC) 500W' and '711' developed from 1-bud stem segment cultures and unrooted plantlet recultures were used. When the roots had elongated 4 to 6 cm and at the initiation of cladophylls in flask cultures the plants were removed from the flasks. Withered shoots were trimmed off, and the plants were immersed in water for 5 min. The plants were then randomly transferred into soil using 2 techniques. The original technique served as control (5, 6). The aseptic plants were transplanted into 10 cm diam unglazed pots containing a mixture of 2 parts sandy loam: 1 part peat: 1 part sand. Each pot was covered with a plastic bag and maintained ca. 27°C and 16 hr photoperiod under a combination of 40-W cool white and Plant Gro fluorescent lamps in a Corrulux greenhouse. The bags were removed and replaced at 3 or 4-day intervals for examining or watering the plants. When the plants had produced 1 or 2 shoots (2 to 3 weeks) the bags were removed. After 1 to 2 weeks the plants were transplanted into 16 cm diam unglazed pots for further development for 1 to 2 months and then transferred into the field. A second technique involved transplanting the aseptic plants into Jiffy 7 peat pots (Fig. 1. A-C) and placing them in an intermittent mist chamber in the greenhouse. The crowns

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