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The Chicories: Witloof (Belgian Endive) and Radicchio Trials — 1986-1987

BY DAVID E. HILL

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Witloof chicory (*Chicorium intybus*), known in the United States as Belgian endive, is grown extensively in Western Europe. It was discovered in the mid-nineteenth century by a Belgian farmer who inadvertently left chicory roots in the dark over winter. In spring the roots had begun to resprout, producing mild-flavored yellowish white leaves. Following perfection of this vegetable at the Brussels Botanical Gardens, it soon began to be exported to the United States in 1911 (Sokolov, 1985). Imports have grown and the U.S. Department of Agriculture reported 3,000 tons in 1983. Today it is no longer considered a gourmet vegetable but is found among other salad greens, and is available throughout the year. Production of witloof, once confined to Western Europe, now occurs in New York state and tests are being conducted in other parts of the country (Maynard and Howe, 1986).

Radicchio, a genetic relative of witloof, has long been grown in the Veneto region of Italy where most imports originate. Foreign imports are now being supplemented by domestic production in California and Florida. The greenish bronze plant has a dense heart whose dark-red leaves have creamy white veins. Unlike witloof, which must be forced, radicchio is field grown for direct harvest. The popularity of radicchio is growing because it adds color and a tangy taste to salads. Red, green, and variegated varieties are being developed for size, earliness of maturity, and mild flavor.

In 1984 and 1985 I tested 26 varieties, called cultivars, of witloof chicory from Holland and Belgium to determine those best suited to Connecticut's soil and climate and two methods of forcing. The 26 cultivars, covering a wide range of maturity, were grown at three sites. I demonstrated that witloof chicory could be grown in Connecticut on diverse soils and that during winter, mature roots could be forced to form chicons (Hill, 1985, 1987). In 1986, I added 12 more cultivars to the trials covering a range in maturity and retested 14 cultivars that had shown promise in 1985.

In 1986 and 1987, I tested a total of 25 cultivars of radicchio, mostly from Europe, to determine those best suited for Connecticut's soil and climate. Most cultivars were grown for fall harvest. Two cultivars remained over winter under hay mulch for early spring harvest, and two were grown from transplants for late spring harvest.

I report storage performance of witloof roots and the yields of chicons forced in winter 1986-87 under two management techniques. I also report on the yield and quality of radicchio cultivars grown in 1986 and 1987.

MATERIALS AND METHODS

Sites and soils. Trials of witloof chicory and radicchio were conducted at the Valley Laboratory, Windsor, on Merrimac sandy loam, a sandy terrace soil with somewhat limited moisture holding capacity and at Lockwood Farm, Mt. Carmel, on Cheshire fine sandy loam, a loamy upland soil with moderate moisture holding capacity. In addition, witloof chicory trials were also conducted at Comstock-Ferre Farm, Wethersfield, on Hadley silt loam, a silty flood plain soil with a high moisture holding capacity.

Seeds and varieties. Graded seed of witloof chicory and radicchio was obtained

from several domestic and Dutch seed companies. The 26 cultivars of witloof chicory provided an array of maturity to accomodate forcing from September through April under two management techniques. They are classified by four periods for forcing: EXTRA EARLY: Arnova, Extrema, Toner; EARLY: Brussels, Daliva, Mitiva, Novibel; MIDDLE: Cerol, Liber Mo, Michelse Mittlevroeg, Regata, Spectra, Tertio, Zoom; LATE: Bea, Carolus, Damast, Flash, Fristo, Fritardif, Kwarosa, Liber Lo, Marriott, Faro, Tardivo, Trilof. Cerol, Regata, and Zoom may also be used for early forcings and Trilof may also be used for middle forcings.

The 25 cultivars of radicchio tested in 1986 and 1987 provided an array of red, green-hearted, and intermediate variegated types. Red-hearted cultivars for fall harvest included Adria, Augusto, Cesare, Dolphina, Garnet Wonder, Guilio, Inca, Marina, Maura, Mesola, Otello, Palla Rosa, Red Devil, Ronette, Silla, and Sista. Red-hearted cultivars mulched with hay over winter and harvested in spring were Red Verone and Treviso. Green-hearted cultivars for fall harvest included Ceriolo, Improved Sugar Loaf, Pan di Zucchero, and Snowflake. Intermediate variegated cultivars included Castelfranco, Chioggia Precoce, and Crosara.

Field management--witloof chicory. Quality roots of witloof chicory require adequate phosphorus, potassium, and magnesium (Kruistum and Buishand, 1982). All sites were fertilized with 150 lb/A P_2O_5 and 300 lb/A K_2O, supplemented with 140 lb/A MgO supplied as Epsom salts (860 lb/A). Nitrogen fertilizer is generally excluded to prevent excessive top growth in the field and to discourage unfurling of outer leaves of the chicon during forcing. Adequate nitrogen is normally supplied by decaying organic matter in the soil. At Windsor, however, 65 lb/A nitrogen was added to compensate for very low nitrogen content of the sandy, organic poor soil. In 1985, the crop at Windsor received no nitrogen and 52% of the stunted roots produced were too small to force (Hill, 1987). Lime was added only at Mt. Carmel to increase the pH of the soil to 6.5.

Seeds were planted by hand at all three sites between May 25 and June 5. Rows 18 inches apart were thinned to 6 inches within the row to a density of 58,080 plants/A, somewhat below an optimum density of 90,000 plants/A. The herbicide Pronamide (KERB 50W) was applied at 3 lb/A immediately after seeding and watered in.

Beginning in late August, roots of witloof chicory were tested periodically for maturity. The roots were split lengthwise, and the fingernail-sized, white patch just below the crown was examined. At maturity this tissue is 1/4 to 3/8 inch thick. Roots with patches thinner than 1/4 inch are immature and will not produce tightly furled chicons (Anon. 1984). Roots with patches thicker than 3/8 inch usually produce unmarketable multiple heads or numerous crown shoots. The optimum root diameter is 1-1/4 to 2-1/4 inch.

In 1986, I harvested roots in two stages at Windsor and Mt. Carmel. Optimum sized roots were pulled between August 8 and October 20 beginning with extra early forcing cultivars and ending with late forcing cultivars. The remaining roots continued to grow and were harvested between October 27 and November 3 in the same sequence. At Wethersfield, two-thirds of the roots of each cultivar were harvested between October 5 and November 25 and placed in cold storage. To test whether roots could be sufficiently vernalized in the field without intermediate cold storage, the remaining third of extra early, early, and three early-to-middle forcing cultivars were harvested between November 25 and December 4 and planted directly in a forcing bed. The remaining roots of middle and late forcing cultivars were left in the field over winter, mulched only by their frozen leaves. Surviving roots were harvested between March 20 and March 30, as soon as the soil thawed. Unfortunately the harvest was interrupted by spring floods which prevented access to the field. Although the test plot was only partially flooded, final harvest could not be completed until April 14, after new crown growth emerged.

During fall harvest, whole plants were lifted and windrowed for 2 days. Wilted heads were severed 1 to 1-1/2 inches above the root crown, and roots were trimmed to 8 inches.

Roots less than 1 inch diameter or excessively forked or from bolted plants were discarded. The tops of spring harvested roots required no trimming.

Storage--witloof chicory. The roots were placed in wire-mesh boxes to ensure ventilation, dipped in 10% bleach solution to control soft rot bacteria, and placed in cold storage at 30-32F. During cold storage, the root becomes vernalized and flower induction is initiated. Until this occurs, the root cannot be forced. In extra early and early maturing cultivars, vernalization may occur in 1 week (Huyskes, 1961). In middle and late maturing cultivars, vernalization is slower and storage up to 8 weeks may be necessary to complete vernalization.

Forcing--witloof chicory. Roots were removed from storage and replanted in darkened enclosures in two environments: a controlled growth room and an unheated barn basement. The optimum temperature for forcing is 60 to 65F (Kruistum and Buishand, 1982). In the controlled growth room, the temperature was maintained at a constant 65F and humidity 95%. The unheated basement of the barn had a daily fluctuation of less than 2F, but in mid-winter cooled to 38F. An electric heating cable buried in the forcing mixture beneath the roots maintained the forcing bed at 65F.

The chambers in the darkened controlled growth room measured 4 by 2 by 1 feet. The sides and bottom were lined with 6-mil black plastic film and were well-drained. The chambers in the barn basement measured 8 by 3 by 1.5 feet. The sides were lined with styrofoam sheets 1 inch thick and the top draped with 6-mil black plastic film to insulate the chambers and to exclude light that would cause the chicons to become green and bitter.

I used two methods of forcing: soil cover and no soil cover. Forcing with soil cover is the traditional European method. About 10 inches of unfertilized 1:1 sand:peat mixture was placed in the forcing chamber. A heating coil, laid in serpentine fashion, was buried about 2 inches from the bottom. Sandy soil may also be used but may require sterilization to eliminate soil-borne diseases. I planted the roots to their crowns about 30 degrees from vertical, using a dibble to make the holes. Plant density was 25 to 30 roots/sq. ft., less when forked roots were used. After planting the roots, the forcing mixture was watered thoroughly. Another 4 inches of 1:2 sand:peat mix was added above the root crowns and watered only lightly. Forcing with soil cover was done only in the barn basement because the air temperature was too low for emerging chicons. In the controlled growth room, all forcing was done without soil cover over the root crowns.

The emerging chicons were usually ready to harvest in 3 to 4 weeks. If grown without soil cover, they were merely severed at the root crown and trimmed to remove unfurled leaves. If grown with soil cover, the chicon and its attached root were uncovered, the root severed and the outer leaves trimmed to remove adhering sand and peat.

The term "forcing" includes planting of roots, growth and harvest of chicons. After harvest of the chicons, the roots were discarded and new roots were planted for the next forcing.

Field management--radicchio. Radicchio trials were fertilized in 1986 and 1987 with 5-10-10 at a rate of 1250 lb/A. Addition of lime to attain a pH of 6.5 was unnecessary in both years at both sites.

For the spring 1987 crop of radicchio, seeds of Marina and Inca were sown March 20 in the greenhouse. Seedlings were grown in Promix BX in standard plastic pots measuring 2-5/8 by 2-1/4 by 2-5/16 inches joined in packs of 36. Water soluble 20-20-20 fertilizer (1 tbsp/gal) was added to the seedlings 3 weeks after germination. Seedlings were moved to a cold frame May 3 to harden and were set in the field May 9 at Mt. Carmel. Plants were set 1 foot apart within rows 1.5 feet apart to a density of 29,040 plants/A.

For fall 1986 and 1987 crops of radicchio, seeds of most cultivars were planted in the field by hand at Windsor and Mt. Carmel between June 9 and June 17. Rows planted 1.5 feet apart were thinned to 1 foot within the row, a density of 29,040 plants/A.

In the 1987 fall crop, however, Crosara, Dolphina, Maura, Mesola, Pan di Zucchero, and

Sista were sown in a greenhouse June 21, moved outside July 2, and transplanted in the field at Mt. Carmel on July 22.

The herbicide Pronamide (KERB 50W) was applied at 3 lb/A immediately after seeding and watered in. Weeds in plots receiving radicchio transplants were controlled only by cultivation.

Red Verone and Treviso over-wintered in the field for spring harvest were covered with 6-8 inches of straw December 4. The straw was removed March 23.

RESULTS

Witloof Chicory

Storage loss of roots. Storage performance was measured as percent loss of roots due to rotting of crowns by fungi and soft rot bacteria. Storage loss is the sum of roots discarded from storage and roots that rotted in the forcing bed. I set a maximum limit of 20% loss. I determined in a general way the weeks in storage of each cultivar before that limit is reached. At least 80% of the roots of most cultivars remained viable 8 to 12 weeks after placing in cold storage. Viability of roots of the extra early forcing cultivars Arnova, Extrema, and Toner was limited to 4 weeks because all roots were forced within 4 weeks of harvest. In these cultivars, vernalization is rapid and roots can be forced after storage of only 7 to 10 days. The roots of Cerol displayed unusual durability with 80% remaining viable after 16 weeks in storage.

Yield and quality. Two measures of success in commercial forcing of witloof chicory are weight of chicons and percent of roots producing high quality chicons. I report the weight of chicons for each cultivar and the number (in parenthesis) of forcings from September to April (Table 1). Because I found no significant differences in weight of chicons from roots grown in Windsor, Wethersfield, and Mt. Carmel, the results have been combined in Table 1.

Chicons forced with soil cover are 14% heavier than those forced without soil cover (Table 1). This is consistent with the results of the 1985 crop (Hill, 1987). Compared to the 1985 crop, chicons of the 1986 crop weighed 0.4 oz more, on average, when forced with and without soil cover, an increase of 16% and 17% respectively. Increased chicon weight is attributed to improved forcing technique that maintained uniform temperature of soil and humidity of ambient air when forcing without soil cover. Forcing of the 1986 crop without soil cover in a room with controlled temperature and humidity was far superior to forcing of the 1985 crop in darkened enclosures in a greenhouse, with fluctuating temperature and humidity.

Several cultivars have higher average chicon weight (Table 1). Among the extra early forcing cultivars, Arnova, Extrema, and Toner averaged 2.5 to 3.6 oz/chicon when grown with soil cover. Without soil cover, Toner averaged nearly 2.5 oz/chicon. The low average weight of Extrema grown without soil cover compared to the average weight with soil cover is consistent with the seed supplier's instructions that it should only be forced with soil cover.

Among the early and early-to-mid-forcing cultivars, average weight of Cerol, Daliva, Regata, and Zoom ranged between 2.6 to 4.2 oz/chicon when grown with soil cover. Daliva's outstanding performance, however, was only from one forcing with soil cover. Without soil cover, Cerol and Mitiva averaged 3.2 and 2.6 oz/chicon respectively.

Among the middle forcing cultivars, the average chicon weight of Michelse Mittelvroeg (cultivar unknown), and Tertio was 2.7 and 3.1 oz/chicon respectively when grown with soil cover. Without soil cover Liber Mo and Spectra each averaged 2.6 oz/chicon.

Among the late forcing cultivars, Marriott consistently yielded most, averaging 3.6 oz/chicon, and produced high quality chicons with tightly furled heads when grown with soil cover. On average, Faro, Flash, Fristo, and Fritardif yielded 2.5 to 3.1 oz/chicon when grown with soil cover. Without soil cover, average chicon weight of Faro was 4.0 oz/chicon. Flash and Carolus also averaged 2.4 to 2.9 oz/chicon when grown without soil cover. The average from Carolus was from only one forcing.

Although size and weight of chicons is a measure of yield, it is highly important for a

TABLE 1--STORAGE PERFORMANCE, PERCENT MARKETABILITY, AND AVERAGE WEIGHT OF BELGIAN ENDIVE CHICONS FOR 1986.

		With Soil Cover		Without Soil Cover	
	Storage Before 20% Loss of Roots Wk	oz/chicon (forcings)	Range of Marketable Chicons %	oz/chicon (forcings)	Range of Marketable Chicons %
EXTRA EARLY					
Arnova	4+	2.5(3)	97-54	2.2(5)	95-48
Extrema	4+	2.8(5)	96-42	1.8(2)	69-48
Toner	4+	3.6(1)	73	2.5(4)	96-64
EARLY					
Brussels	8	2.2(4)	52-24	-	-
Daliva	8	4.2(1)	95	1.9(7)	70-24
Mitiva	8	2.2(2)	48-13	2.6(3)	99-36
Novibel	8	2.0(5)	88-61	-	-
EARLY-MIDDLE					
Cerol	16	2.6(4)	69-26	3.2(1)	58
Regata	8	2.8(5)	75-17	-	-
Zoom	12	2.6(1)	57	2.2(6)	82-35
MIDDLE					
Liber Mo	12	2.3(5)	81-39	2.6(1)	48
Michelse	12	2.7(7)	75-22	-	-
Spectra	8	-	-	2.6(3)	66-26
Tertio	12	3.1(4)	97-21	-	-
LATE					
Bea	8	2.2(2)	76-52	2.3(2)	56-44
Carolus	12	-	-	2.9(1)	47
Damast	8	-	-	2.1(2)	19-9
Faro	12	2.7(4)	58-18	4.0(2)	15-13
Flash	12	2.5(1)	84	2.4(2)	47-9
Fristo	12	2.8(5)	55-32	-	-
Fritardif	8	3.1(5)	60-10	-	-
Kwarosa	8	2.0(1)	43	2.1(2)	58-8
Liber Lo	8	-	-	2.3(3)	36-10
Marriott	8	3.5(5)	77-23	-	-
Tardivo	8	2.2(2)	58-34	2.3(2)	63-21
Trilof	8	2.1(3)	17-10	-	-
AVERAGE		2.7		2.3	

large percent of the roots to produce marketable chicons. It is evident that success and mediocrity was mixed for individual forcings of each cultivar (Table 1). A low percent of marketable chicons with a high average weight may produce a greater overall yield when compared to a high percent of marketable chicons with a low average weight. Roots grown at Wethersfield had the highest percent of marketable chicons for 12 of 22 cultivars grown with soil cover and 13 of 17 grown without soil cover (Table 1). About 70 to 97% of the Wethersfield roots of extra early through middle forcing cultivars produced marketable chicons. The percent marketable chicons ranged from 35 to 84 among late forcing cultivars kept longer in storage. Much of this decrease was due to rotting in storage and in the forcing bed. In contrast, the quality of chicons from roots grown at Windsor was fair for early forcing cultivars and poor for late forcing cultivars. Roots from extra early through middle forcing cultivars had high percentages of imperfect chicons. The greatest defect of chicons from roots grown at Windsor was unfurling of outer leaves and failure of the center leaves to keep pace with outer leaves, thus creating a chicon with a hollow center. Many overmature roots formed multiple small chicons from the root crown. The unfurling of leaves and hollow chicons are thought to be due to too much nitrogen stored in the roots. In my efforts to overcome stunting of the crop observed in 1985, I added 65 lb N/A at Windsor. This rate was probably too high. In retrospect, the advice of European growers to shun applications of nitrogen is well taken.

The quality of chicons from roots grown at Mt. Carmel was mixed. The quality of chicons from roots of late forcing cultivars was better at Mt. Carmel than those grown at Windsor. The quality of chicons of early to middle forcing cultivars was poorer at Mt. Carmel compared to Windsor.

Yield and quality—direct forcing without cold storage. Because chilling is required to vernalize the roots and cold storage is expensive, I delayed harvest of a third of the roots from Wethersfield. Roots of extra early, early, and early to middle forcing cultivars

TABLE 2--AVERAGE WEIGHT AND PERCENT MARKETABLE BELGIAN ENDIVE CHICONS PRODUCED BY DIRECT FORCING, 1986-87.

	Soil cover		No soil cover	
	oz/ chicon	Marketable %	oz/ chicon	Marketable %
ROOTS HARVESTED FALL 1986				
EXTRA EARLY				
Arnova	-	-	3.2	89
Extrema	2.4	100	-	-
Toner	-	-	2.3	100
EARLY				
Brussels	3.9	81	-	-
Daliva	3.5	70	3.3	100
Mitiva	3.7	96	-	-
Novibel	2.3	84	-	-
EARLY-MIDDLE				
Cerol	3.7	100	-	-
Regata	3.6	77	3.1	85
Zoom	3.6	91	-	-
AVERAGE	3.4		2.9	
ROOTS HARVESTED SPRING 1987				
MIDDLE				
Liber Mo	-	-	1.3*	19
Michelse	1.6*	17	-	-
Spectra	1.6*	26	1.5*	27
Tertio	1.8	19	-	-
LATE				
Bea	1.8	26	2.1	17
Carolus	1.6	83	-	-
Damast	1.5	54	2.0	34
Faro	1.8	33	-	-
Flash	1.5*	10	-	-
Fristo	2.0	53	-	-
Fritardif	2.2	16	-	-
Kwarosa	2.1	38	2.4	38
Liber Lo	-	-	1.7	60
Marriott	1.4	23	-	-
Tardivo	1.4	70	2.2	30
Trilof	1.8	8	-	-
AVERAGE	1.7		1.9	

* Late spring harvest of roots-new growth required extra trimming of the chicon.

were harvested in late November to early December and placed directly in a forcing bed. Although only represented by a single forcing, the results were outstanding (Table 2). The average weight of all cultivars grown with soil cover averaged 3.4 oz/chicon. Cultivars grown without soil cover averaged 2.9 oz/chicon. These averages are significantly greater than the averages of chicons from roots grown at Wethersfield and placed in cold storage for 4 to 8 weeks. It is likely that the greater average chicon weight is due to larger roots for direct forcing than those harvested earlier for storage. The extra 3 weeks in the field produced larger root stocks. The percent of marketable chicons ranged from 70 to 100. The results of direct forcing in 1986 prompted further study in 1987. Although the results from 1987 are not complete, it is abundantly clear that planting late in June is far superior to planting in mid-to-late May. Vernalization of extra early to middle forcing cultivars takes place in the field as the soil cools. This allows direct forcing for harvest of chicons from late December through mid-January.

Roots of middle and late forcing cultivars left in the field over winter and harvested late in March to mid-April as soon as the soil thawed were also forced directly without cold storage.

Average chicon weight of roots harvested in spring declined for two reasons. First, surviving roots were only 1-inch in diameter. Larger mature roots whose crowns projected above the soil line were killed. Second, new growth began to emerge in early April and had to be trimmed. These new leaves would have been part of the chicon had the roots been harvested earlier and their removal reduced the size and weight of the chicon during forcing. Despite smaller roots and trimmed tops, the average weight was about 1.7 to 1.9 oz/chicon when grown with or without soil cover. Fritardif had the heaviest chicon weight when grown with soil cover and Kwarosa without soil cover, but percent marketable chicons was very low. Although the chicon weight is only 1.4 to 1.6 oz/chicon, the percent of marketable chicons of Carolus and Tardivo exceeded 70%.

Radicchio

Yield of the direct-seeded crop. The yield of radicchio is measured in terms of head weight and percentage of plants producing heads. From these measurements, I calculated the total yields and have expressed them in lb/A (Table 3). In 1986, seven cultivars had an average head weight of 5.0 oz/head at Mt. Carmel compared to 3.9 oz/head at Windsor, a difference of 28%. Although the average percentage of plants producing heads at Mt. Carmel was 7% less than Windsor, the greater average head weight produced 20% greater total yield at Mt. Carmel (7185 lb/A) compared to Windsor (5990 lb/A).

In 1987, the average head weight of all cultivars at Mt. Carmel, 4.8 oz., was 7% greater than the 4.5 oz. at Windsor. The percentage of plants producing heads at Mt. Carmel was 7% greater than at Windsor. The average total weight of all cultivars was 15% greater at Mt. Carmel (7005 lb/A) compared to Windsor (6072 lb/A). It is clear that radicchio plants produce larger heads in the loamy soil at Mt. Carmel with its moderate moisture holding capacity than at Windsor where the sandy soils are somewhat droughty and retention of nutrients is poor. A side dressing of fertilizer may be necessary at mid-season in sandy soils.

Several cultivars are noteworthy. Augusto, Inca, and Marina produced over 3 tons/A at Mt. Carmel and Windsor in 1986 and 1987. Over 85% of the plants produced marketable heads in the fall. In 1987, Cesare, Red Devil, and Silla, tested for the first time, also yielded over 3 tons/A. Red Devil yielded over 4 tons/A with over 80% of the plants producing marketable heads at both sites. Palla Rosa yielded 3.0 tons/A in 1986 at both sites but only 2.5 tons/A at Windsor in 1987.

The green-headed cultivars, Ceriolo, Improved Sugar Loaf, and Snowflake and variegated green-and-red-headed Castelfranco and Chioggia Precoce failed to produce marketable heads. Red Verone and Treviso, spring harvested types that were mulched with hay over the winter of 1986-87, rotted in the field. Only 10% produced marketable heads.

Yields of the transplanted crop. In 1987, at Mt. Carmel, radicchio transplants produced

a spring crop for harvest late June through mid-July. Inca and Marina were chosen because their fall crops were excellent in 1986. The average weight of Marina (5.3 oz/head) and Inca (4.5 oz/head) was comparable to the fall crop. Compared to the fall crop, Marina had 18% less and Inca, 8% less marketable heads. Despite lower percentages of marketable heads, both cultivars produced over 3 tons/A. Although only two cultivars were tested at one site, the results suggest that a spring crop of radicchio is worthy of further testing in 1988.

In 1987, six cultivars were tested for yield and quality at Mt. Carmel only. A very limited seed supply required that germination for production of transplants be under optimum conditions in a greenhouse. The yield and quality of most of these cultivars was outstanding. Crosara, a variegated pale green

TABLE 3--YIELD OF DIRECT-SEEDED RED-HEARTED RADICCHIO AT WINDSOR AND MT. CARMEL, FALL 1986 AND 1987*

	WINDSOR			MT. CARMEL		
	Average Weight oz/head	Marketable %	Yield lb/A	Average Weight oz/head	Marketable %	Yield lb/A
FALL 1986						
Augusto	3.8	93	6482	5.1	85	7899
Garnet Won.	3.7	58	3874	5.9	42	4513
Guilio	3.4	91	5550	4.2	85	6418
Inca	3.8	97	6761	4.2	94	7097
Marina	4.0	93	6752	6.2	89	10080
Palla Rosa	4.5	81	6586	5.4	75	7405
Ronette	3.8	85	5924	4.8	79	6882
AVERAGE	3.9	85	5990	5.0	78	7185
FALL 1987						
Adria	3.7	68	4542	-	-	-
Augusto	4.8	77	6708	5.6	84	8538
Cesare	4.5	80	6505	4.8	78	6795
Guilio	4.0	62	4501	4.3	73	5724
Inca	4.0	86	6244	4.6	86	7243
Marina	5.1	72	6691	4.8	87	7579
Otello	4.0	57	4138	5.1	78	7248
Palla Rosa	4.5	61	4960	4.5	82	6668
Red Devil	5.6	80	8131	5.4	84	8294
Ronette	3.0	73	4028	4.5	73	5936
Silla	5.3	92	8817	4.0	83	6026
AVERAGE **	4.5	74	6072	4.8	81	7005

* Castelfranco, Ceriolo, Chioggia Precoce, Improved Sugarloaf, and Snowflake were also grown, but did not form heads in the fall. Red Verone and Treviso had low survival rates when mulched with hay over winter.

** Adria not included in average.

TABLE 4--YIELD OF TRANSPLANTED RADICCHIO AT MT. CARMEL, SPRING AND FALL 1987.

	Weight oz	Average Heads %	Market Yield lb/A
SPRING 1987			
Inca (R)*	4.5	78	6334
Marina (R)	5.3	69	6603
FALL 1987			
Crosara (V)	12.0	82	17860
Dolphina (R)	8.5	100	15391
Maura (R)	7.2	94	12284
Mesola (R)	8.8	89	14215
Sista (R)	6.6	92	10954
Pan di Zucchero (G)	20.7	36	13486

* (R)=Red; (V)=Variegated; (G)=Green

cultivar flecked with red, yielded nearly 9 tons/A (Table 4). The mild flavored heads averaged 12 oz/head and were similar in texture and density to large heads of lettuce. Yield of red-hearted Dolphina, Maura, Mesola, and Sista ranged from 5.5 to 7.5 tons/A. Marketable heads ranged from 89 to 100%. Pan di Zucchero had large elongated pale green heads whose average weight was 1.3 lb/head. Despite only 36% marketable heads, it yielded more than 6.5 tons/A.

CONCLUSIONS

My experiments with Belgian endive and radicchio demonstrate that chicories can be successfully grown in the soils and climate of Connecticut. Production of Belgian endive roots for forcing is simple and relatively inexpensive. Storage and forcing of roots requires careful control of temperature and humidity to produce quality chicons that can compete with European imports. Sowing seed in late June delayed maturity of extra early, early, and middle forcing cultivars and allowed mature plants to vernalize in the cool soils of late fall. The roots can be forced directly without intermediate cold storage. Earlier seeding caused the roots to be overmature by the time the soils cooled, thus necessitating an earlier harvest and cold storage for vernalization.

Production of radicchio by direct seeding for fall markets is simple and inexpensive. Experiments showed that transplants also may be feasible for spring production, and will expand the availabilty of locally grown radicchio in the marketplace and opportunities for Connecticut growers.

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