The Connecticut Agricultural Experiment Station, New Haven

Romaine and Looseleaf Lettuce Trials 1996-1997

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SUMMARY

During 1996-1997, cultivar trials of Romaine and looseleaf lettuce were conducted in spring and fall at Windsor (inland, sandy terrace soil) and at Mt. Carmel (coastal, loamy upland soil). In 1996, average yield of 13 cultivars of Romaine lettuce harvested in spring Crop 1 at Windsor was 25,290 lb/A compared to 37,310 lb/A at Mt. Carmel. Moisture deficits in May and June only at Windsor reduced head weight and total yield. In spring Crop 2 at Mt. Carmel, average yield of 13 cultivars was 14,200 lb/A, 61% less than the yield in Crop 1. The yield was reduced by premature bolting, tipburn, and head rot. At both sites, yields of Romaine cultivars Green Towers, Kalura, and Jericho exceeded 30,000 lb and were of excellent quality. Although yield of Olga was average, its quality was excellent.

In fall Crops 1 and 2, average yield of 13 cultivars was 18,170 lb/A and 12,310 lb/A respectively at Windsor compared to 26,190 lb/A and 17,340 lb/A respectively at Mt. Carmel. Lower yields in fall Crops 1 and 2 at Windsor were due to premature bolting and development of tipburn. Cultivars Ideal, Jericho, Kalura, Plato, and Romulus were resistant to premature bolting, but Jericho and Kalura were susceptible to tipburn. Best yield and quality were exhibited by Ideal and Plato. In Crop 3 at Mt. Carmel (coastal), planted September 1, most cultivars produced marketable yields. Yields of Jericho, Plato, Olga, Verte Mar, and Ideal exceeded 20,000 lb/A and were of excellent quality without tipburn or premature bolting. At Windsor (inland), no cultivars reached marketable size in this late planting.

In 1997, average yield of seven cultivars of looseleaf lettuce in two spring crops was 21,270 lb/A at Windsor compared to 22,120 lb/A at Mt. Carmel. Yield of Two Star, Salad Bowl, Royal Green, and Slo Bolt exceeded 23,000 lb/A. The quality of most cultivars was excellent. Tipburn developed on 10% of Waldman's Dark Green and Slo Bolt at Windsor and 30-90% of plants of these two cultivars respectively at Mt. Carmel.

In fall Crops 1 and 2, average yield of six cultivars at Windsor was 21,020 lb/A and 20,540 lb/A respectively compared to 13,515 lb/A and 17,720 lb/A respectively at Mt. Carmel. Lower yields at Mt. Carmel were due to drought in July while above-average rainfall at Windsor produced larger heads. In fall Crops 1 and 2, yield and quality of Simpson Elite was excellent. Waldman's Dark Green and Royal Green were most susceptible to tipburn. Two Star developed tipburn in about 20% of its plants. In fall Crop 3, average yield of six cultivars at Windsor was 22,160 lb/A with all cultivars reaching marketable size. In contrast, growth of the crop at Mt. Carmel was exceedingly slow and no cultivars reached marketable size.

Tipburn and premature bolting developed in some crops of Romaine in 1996 and looseleaf lettuce in 1997. The crops grown in the sandy soil at Windsor were affected most with reduced yields. Tipburn usually developed after droughty periods were ended by sufficient rain to speed growth as the plants neared maturity. The Romaine cultivar Ideal was resistant to tipburn and premature bolting. Jericho, Kalura, Plato, and Romulus were most susceptible to tipburn. The red cultivars, Cimmaron, Rosalita, and Rouge d'Hiver bolted prematurely in all spring and fall crops. The looseleaf cultivars Royal Green, Simpson Elite, and Salad Bowl were most resistant to tipburn; Slo Bolt and Waldman's Dark Green the least. Royal Green and Waldman's Dark Green were most susceptible to bolting, especially in fall crops.

Maturity of crops planted in July and early August shortens 4-5 weeks for Romaine lettuce and 3 weeks for looseleaf lettuce compared to earlier and later plantings.

Romaine and Looseleaf Lettuce Trials 1996-1997

By David E. Hill

Lettuce ranks second among all vegetables produced for consumption in the United States. According to USDA statistics, 6.85 billion pounds were produced in 1997 with California and Arizona the two major suppliers (Anon 1998). Lettuce is available year round because winter production occurs in frost-free areas in the United States and is supplemented with imports from Mexico. Summer crops are augmented with production in Michigan, Wisconsin, New York, and New Jersey (Ryder 1979).

Lettuce *(Lactuca sativa)* may be divided into five types: crisphead, butterhead, Romaine (cos), looseleaf, and stalk. I concentrated on Romaine and looseleaf types because of their growing popularity. Trials of crisphead lettuce were published earlier (Hill 1993).

Production in Connecticut. In the early 1900's, lettuce was grown in Windsor along the floodplain of the Connecticut River and in vegetable producing areas of Cheshire, Wallingford, and North Haven. Most of these areas are no longer in production due to urban development. In 1992, the Connecticut Census of Agriculture reported 94 acres of lettuce grown on 92 farms. Although the census did not differentiate among lettuce types, most of the production is crisphead and Romaine. Butterhead lettuce is grown hydroponically in Hartford. Most of the lettuce in Connecticut is grown for direct marketing through roadside stands and farmers' markets.

Current outlook. Although total consumption of lettuce has declined 6% from 1990 to 1997 (Swenson 1997) consumer taste has shifted from crisphead lettuce to increasing consumption of Romaine and other leaf lettuces. Caesar salad, whose main ingredient is Romaine lettuce, has become the most popular salad in restaurants and as a fresh-cut salad mix sold in supermarkets. The recent rapid growth of the food-service industry, which encompasses fast-food chains, restaurants, school and corporate cafeterias, and hospitals, has created a large demand for lettuce. The food-service industry uses about one-third of all lettuce produced in the United States (Anon 1990). Further, increased demand in the past decade is due to increasing numbers of people who include salads in their daily diet.

Food processors, chefs, and consumers extol the virtues of Romaine lettuce, crispness in cold storage and little waste. Per capita consumption of Romaine and other leaf lettuces increased from 3.8 lbs in 1990 to 6.4 lbs in 1996 (Swenson 1997). Testimony to its increased popularity is seen in recent acreage estimates. In Monterey County, the largest lettuce producing county in California, acreage of Romaine increased from 12,500 in 1993 to 20,050 in 1996 (Harvey 1997). Acreage of Romaine in the winter-growing area of Yuma, Arizona increased from 2,850 in 1992 to 7,360 in 1996 (Anon 1996).

Production of Romaine and looseleaf lettuce for direct marketing sales seems to be the most feasible because roadside prices are largely independent of California wholesale prices at the time of harvest.

In 1996, thirteen cultivars of Romaine lettuce and in 1997, seven cultivars of looseleaf lettuce were grown from transplants in two spring and three fall crops at the Valley Laboratory in Windsor and Lockwood Farm in Mt. Carmel (Hamden). I report yield and quality of these cultivars in this bulletin. I also discuss the impact of premature bolting and development of tipburn on yield and maximizing yield through cultivar selection, planting dates, and site selection.

METHODS AND MATERIALS

Soils. Romaine and looseleaf lettuce trials were conducted at the Valley Laboratory, Windsor on Merrimac

Table 1. Soil and crop management of Romaine and Looseleaf lettuce, 1996-1997.

Activity	Spring Crops		Fall Crops
SOIL FERTILIZATION			
10-10-10	1000 lb/A	(100 lb N/A)	1000 lb/A
Calcium nitrate	190 lb/A	(30 lb N/A)	190 lb/A
(Side dress 1 month after transplanting)			
Lime (to attain pH 6.5)	None		None
PLANTING DATES			
Seeding in greenhouse or cold frame	Crop 1	March 12	June 16-18
	Crop 2	March 26	July 1-2
	Crop 3	-	July 22-24
Transfer to cold frame	Crop 1	April 15-16	-
	Crop 2	April 24	-
Transplanted to field	Crop 1	April 25-29	July 18-22
	Crop 2	May 7-14	August 5-9
	Crop 3	-	August 28-31
PEST CONTROL (Windsor only)			
1996	None		8' Deer fence
1997	8' Deer fence		8' Deer fence
NUMBER OF IRRIGATIONS			
Windsor	0		1
Mt. Carmel	0		1
WEED CONTROL			
Cultivations	2		2

sandy loam, a sandy terrace soil with somewhat limited moisture holding capacity, and at Lockwood Farm, Mt. Carmel, on Watchaug loam, a moderately well drained loamy upland soil with moderately high moisture holding capacity.

Cultivars. Seeds were obtained from several domestic suppliers. In 1996, the 13 cultivars of Romaine were Cimmaron (red), Green Towers, Ideal, Jericho, Kalura, Olga, Parris Island, Plato, Romance, Romulus, Rosalita (red), Rouge d'Hiver (red), and Verte Mar. In 1997, the seven cultivars of looseleaf lettuce were Royal Green, Salad Bowl, Simpson Elite, Slo Bolt, Super Prize, Two Star, and Waldman's Dark Green.

Culture. Seeds for the first and second spring plantings were sown 2 weeks apart in a greenhouse maintained at 50-70F. Four-week-old seedlings were moved to a cold frame for hardening 10-14 days prior to transplanting in the field. The seedlings were transplanted at a 12-inch spacing in rows 24 inches apart providing a density of 21,780 plants/A. Each planting consists of five replicated blocks with each cultivar (six plants/cultivar) randomly planted in rows within each block. The details of management of soil and crops and pertinent dates are listed in Table 1.

Seeds for the fall plantings were sown at 2-week intervals in a cold frame for germination. Five to six-week-old seedlings were transplanted in the field when they were about 3-4 inches tall. The third fall planting in both years was delayed because of slow seedling growth.

The seedlings were grown in Promix BX in 36-pot packs, each pot 2 5/8 x 2 1/4 x 2 5/16 inches. Water soluble 20-10-20 fertilizer (1 tbsp/gal) was added to the seedlings 1 week before transplanting. Sidedressing the crop with nitrogen, supplied as calcium nitrate, was important because lettuce plants make about 80% of their growth during the last 3-4 weeks before harvest (Zink and Yamaguchi 1962).

The heads of all cultivars were harvested when they reached marketable size. Heads of Romaine were loose to firm and weighed 1.25-2.00 lb. Heads of looseleaf lettuce were loose to slightly firm and weighed 0.9-1.1 lb.

Rainfall. Rainfall distribution throughout the growing

Table 2. Departure of monthly rainfall (inches) from normal during May-October.

	1996		1997	
	WINDSOR	MT. CARMEL	WINDSOR	MT. CARMEL
MAY	-0.57	0.56	0.16	-1.49
JUNE	-0.55	0.25	-0.58	-0.04
JULY	3.20	3.31	1.64	-1.68
AUGUST	-1.40	-0.45	2.55	5.23
SEPTEMBER	3.35	1.05	-2.40	-2.43
OCTOBER	3.07	5.12	-1.20	-1.59

season (May-October) for 1996-1997 is shown in Table 2. The inches of rainfall in each column represents the departure from the mean monthly rainfall for Hartford (near Windsor) and Mt. Carmel reported by the National Weather Service. Total rainfall during the 1996 and 1997 growing seasons was 26.2 and 19.3 inches at Windsor, and 29.8 and 17.9 inches at Mt. Carmel compared to a 30-year average of 19.2 inches at Windsor and 19.9 inches at Mt. Carmel. Although rainfall in 1996 at Windsor was 7.1 inches above normal for the growing season, water deficits in May, June, and August ranged between 0.5-1.0 inches. At Mt. Carmel, a water deficit occurred only in August. Irrigation was required at both sites in August to alleviate stress on newly planted seedlings.

Although total rainfall in the 1997 growing season at Windsor was 0.2 inches above normal, water deficits between 0.6 and 2.4 inches were observed in June, September, and October. At Mt. Carmel, water deficits exceeding 1.5 inches occurred in all months of the growing season except June and August. Although heavy rains in August, exceeding 8.1 inches, benefited newly planted seedlings, deficits in September and October slowed growth of the lettuce plants. Irrigation in September at both sites helped speed growth as the plants reached maturity.

YIELD AND QUALITY

Romaine—Spring Crops 1996. In Crop 1, transplanted April 30-May 1, the average yield of 12 cultivars was 25,290 1b/A at Windsor compared to 37,310 lb/A at Mt. Carmel, a difference of 48% (Table 3). The greater average yield at Mt. Carmel was due to greater average head weight of all cultivars (1.8 lb) compared to Windsor (1.4 lb). At Windsor, heads were smaller because of moisture deficits in May and June compared to greater-than-average rainfall in those months at Mt. Carmel (Table 2). At both sites, 91-93% of all heads were marketable with excellent quality.

At Windsor, yield of Green Towers exceeded 37,000 lb/A, and Kalura exceeded 33,000 lb/A. At Mt. Carmel, yield of Jericho exceeded 49,000 lb/A. Yields of Green Towers, Kalura, Plato, and Romance exceeded 40,000 lb/A. Quality of Olga, an upright heading cultivar and Kalura, an upright non-heading cultivar were excellent. Minor tipburn symptoms appeared on about 10% of most cultivars at both sites. Tipburn in Jericho was the most severe (30%) among all cultivars. Least affected by tipburn were Olga, Green Towers and Parris Island. Premature bolting in the red cultivars Cimmaron, Rosalita, and Rouge d'Hiver was extensive.

In Crop 2, transplanted May 14-15, the average yield of 13 cultivars at Mt. Carmel was 14,200 lb/A. The average yield at Windsor could not be determined due to extensive deer browse. Only Olga, Rosalita, and Rouge d'Hiver had been harvested before the damage occurred. The yield of Olga was 24,000 lb/A. Rosalita and Rouge d'Hiver were harvested because of premature bolting in 50-63% of the plants. Yield of both cultivars averaged 13,000 lb/A. Average yield in Crop 2 at Mt. Carmel was 61% less than the average yield in Crop 1. The yield was reduced by bolting, tipburn and head rot.

At Mt. Carmel, yield of Kalura and Jericho exceeded 31,000 lb/A. Both were free of premature bolting and tipburn was minor (<5%). Premature bolting was extensive in the red cultivars Cimmaron, Rosalita, and Rouge d'Hiver (70-93%).

Romaine—Fall Crops 1996. In Crop 1, transplanted July 18-19, average yield of 13 cultivars at Windsor was 18,170 lb/A compared to 26,190 lb/A at Mt. Carmel, a difference of 44% (Table 4). Greater yield at Mt. Carmel, compared to Windsor, was due to greater average percent of heads harvested (70 vs. 46). The low average percent harvested at Windsor was largely due to premature bolting in Green Towers, Parris Island, Rosalita, Rouge d'Hiver, and Verte Mar (70-97%).

At Windsor, yield of Jericho exceeded 40,000 lb/A, Yield of Ideal and Plato exceeded 33,000 lb/A, well above average. Although the yield of Olga was slightly below average, its quality was excellent with no tipburn observed.

Table 3. Yield of Romaine lettuce at Windsor and Mt. Carmel, Spring 1996

	WINDSOR				MT. CARMEL			
	Heads hvst.	Avg. wt.	Total yield[v]		Heads hvst.	Avg. wt.	Total yield[v]	
Cultivar	%	lb.	lb/A[w]	Cartons/A[x]	%	lb.	lb/A[w]	Cartons/A[x]
CROP 1		(Planted May 1)				(Planted April 30)		
Cimmaron	67	1.1	16,050c	608	93	1.5	30,380bc	844
Green Towers	100	1.7	37,020a	908	100	1.9	41,380ab	908
Ideal	-	-	-	-	63	1.6	21,950c	572
Jericho	100	1.4	30,490b	908	87	2.6	49,270a	790
Kalura	97	1.6	33,800ab	881	97	2.0	42,250ab	881
Olga	100	1.4	30,490b	908	77	1.8	30,190bc	699
Parris Island	100	1.5	32,670ab	908	100	1.8	39,200ab	908
Plato	90	1.6	31,360ab	817	93	2.1	42,540ab	844
Romance	100	1.3	28,310b	908	97	1.6	33,800b	881
Romulus	93	1.3	26,330b	844	83	2.7	48,810a	753
Rosalita	83	1.3	23,500bc	753	77	1.7	28,510bc	699
Rouge d'Hiver	90	1.0	19,600c	817	87	1.4	26,530bc	790
Verte Mar	93	1.2	24,310bc	844	100	1.6	34,850b	908
CROP 2		(Planted May 14)				(Planted May 15)		
Cimmaron	0[y]				7	1.2	1,830e	64
Green Towers	0[z]				30	1.2	7,840d	272
Ideal	0[z]				57	1.4	17,380bc	518
Jericho	0[z]				80	1.8	31,360a	726
Kalura	0[z]				90	1.8	35,280a	817
Olga	80	1.4	24,390a	726	63	1.4	19,210b	572
Parris Island	0[z]				23	1.4	7,010d	209
Plato	0[z]				37	1.7	13,700c	336
Romance	0[z]				78	1.1	17,490bc	708
Romulus	0[z]				70	1.4	21,340b	636
Rosalita	37	1.5	12,090b	336	30	1.4	9,150d	272
Rouge d'Hiver	50	1.3	14,160b	454	13	1.1	3,110e	118
Verte Mar	0[z]				10	1.4	3,050e	91

[v] Based on 1' x 2' spacing or 21,780 plants/A.

[w] Mean separation within columns for each crop by Tukey's HSD multiple comparison test at P=0.05. Values in columns followed by the same letter in each crop did not differ significantly.

[x] Based on a standard 24 count cartons weighing about 40 lb.

[y] All bolted prematurely.

[z] Extensive deer browse.

Table 4. Yield of Romaine lettuce at Windsor and Mt. Carmel, Fall 1996

	WINDSOR				MT. CARMEL			
	Heads hvst.	Avg. wt.	Total Yield[v]		Heads hvst.	Avg. wt.	Total yield[v]	
Cultivar	%	lb.	lb/A[w]	Cartons/A[x]	%	lb.	lb/A[w]	Cartons/A[x]
CROP 1	(Planted July 19)				(Planted July 18)			
Cimmaron	50	1.0	10,890cd	454	33	1.0	7,190d	300
Green Towers	7	1.5	2,290d	64	100	1.9	41,380a	908
Ideal	87	2.1	39,790a	790	93	1.7	34,430ab	844
Jericho	80	2.3	40,080a	726	97	2.1	44,370a	881
Kalura	73	2.1	33,390b	663	90	2.0	39,200a	817
Olga	87	1.5	28,420b	790	100	1.6	34,850ab	908
Parris Island	3	1.6	1,040d	27	40	1.4	12,200cd	363
Plato	73	2.1	33,390b	663	100	1.8	39,200a	908
Romance	40	1.8	15,680c	363	50	1.7	18,510c	454
Romulus	47	1.6	16,380c	427	83	1.6	28,920b	753
Rosalita	30	1.1	7,190cd	272	23	0.9	4,510d	209
Rouge d'Hiver	10	1.2	2,610d	91	20	1.0	4,360d	182
Verte Mar	13	1.8	5,100cd	118	80	1.8	31,360b	726
CROP 2	(Planted August 7)				(Planted August 8)			
Cimmaron	6	1.0	1,310d	54	57	0.7	8,690bc	0[y]
Green Towers	40	1.3	11,330c	363	33	1.0	7,190c	300
Ideal	83	1.6	28,920a	753	97	1.1	23,240a	881
Jericho	57	1.6	19,860b	518	70	1.5	22,870a	636
Kalura	43	1.7	15,920bc	390	77	1.5	25,160a	699
Olga	30	1.5	9,800c	272	93	1.1	22,280a	844
Parris Island	53	1.3	15,010bc	481	80	0.8	13,940b	726
Plato	80	1.7	29,620a	726	80	1.4	24,390a	726
Romance	57	1.3	16,140bc	518	97	1.1	23,240a	881
Romulus	83	1.3	23,500b	753	83	1.1	19,880ab	753
Rosalita	20	1.0	4,360d	182	33	0.6	4,310c	0[y]
Rouge d'Hiver	7	1.0	1,520d	64	80	0.6	10,450bc	0[y]
Verte Mar	27	1.5	8,820c	245	70	1.3	19,820ab	636
CROP 3	(Planted August 31)				(Planted August 31)			
Cimmaron	50	0.3	3,270c	0[y]	53	1.4	4,620d	481
Green Towers	93	0.5	10,130b	0[y]	80	1.1	19,170b	726
Ideal	97	0.6	12,670ab	0[y]	83	1.2	21,690ab	753
Jericho	97	0.5	10,560b	0[y]	90	1.3	25,480a	817
Kalura	80	0.5	8,710b	0[y]	50	1.5	16,340b	454
Olga	100	0.7	15,250a	0[y]	77	1.3	21,800ab	699
Parris Island	90	0.6	11,760ab	0[y]	70	0.9	13,720bc	636
Plato	90	0.8	15,680a	817	77	1.4	23,480a	699
Romance	93	0.6	12,150ab	0[y]	87	0.9	17,050b	790
Romulus	90	0.4	7,840bc	0[y]	77	1.2	20,120ab	699
Rosalita	73	0.5	7,950bc	0[y]	80	0.7	12,200c	0[y]
Rouge d'Hiver	90	0.5	9,800b	0[y]	70	0.6	9,150cd	0[y]
Verte Mar	83	0.6	10,850b	0[y]	80	1.2	20,910ab	726

[v] Based on 1' x 2' spacing or 21,780 plants/A.

[w] Mean separation within columns for each crop by Tukey's HSD multiple comparison test at P=0.05. Values in columns followed by the same letter in each crop did not differ significantly.

[x] Based on a standard 24 count cartons weighing about 40 lb.

[y] Heads less than 0.8 lb. have little commercial value.

Table 5. Yield of looseleaf lettuce at Windsor and Mt. Carmel, Spring 1997.

	WINDSOR				MT. CARMEL			
	Heads hvst.	Avg. wt.	Total yield[v]		Heads hvst.	Avg. wt.	Total yield[v]	
Cultivar	%	lb.	lb/A[w]	Cartons/A[x]	%	lb.	lb/A[w]	Cartons/A[x]
CROP 1	(Planted April 28)				(Planted April 25)			
Looseleaf								
Royal Green	100	0.9	19,680b	908	100	1.1	23,960ab	908
Salad Bowl	90	1.0	20,260b	817	100	1.2	26,140a	908
Simpson Elite	100	1.0	21,780ab	908	100	1.0	21,780ab	908
Slo Bolt	100	1.0	21,780ab	908	100	1.1	23,960ab	908
Super Prize	100	1.1	23,960a	908	100	1.0	21,780ab	908
Two Star	100	1.2	26,140a	908	97	1.3	27,460a	881
Waldman's Dk. Grn.	100	0.9	19,680b	908	100	0.9	19,600b	908
CROP 2	(Planted May 7)				(Planted May 8)			
Looseleaf								
Royal Green	83	1.0	18,080b	754	90	1.1	21,560a	817
Salad Bowl	97	1.1	23,240a	881	93	1.1	22,280a	844
Simpson Elite	97	1.1	23,240a	881	97	1.0	21,130ab	881
Slo Bolt	97	0.9	19,600ab	881	100	0.8	17,420b	908
Super Prize	97	0.9	19,600ab	881	93	0.9	19,600ab	844
Two Star	97	1.0	21,130ab	881	97	1.0	21,130ab	881
Waldman's Dk. Grn.	90	1.0	19,600ab	817	100	1.0	21,780a	908

[v] Based on 1'x 2' spacing or 21,780 plants/A.

[w] Mean separation within columns for each crop by Tukey's HSD multiple comparison test at P=0.05. Values in columns followed by the same letter in each crop did not differ significantly.

[x] Based on standard 25 lb. - 24 count cartons.

At Mt. Carmel, yield of Jericho and Green Towers exceeded 40,000 lb/A. Average weight of heads exceeded 1.9 lb, well above average (1.6 lb), and 97-100% of heads were of marketable quality. Yields of Kalura, Olga, Plato, and Verte Mar exceeded 31,000 lb/A, and quality was also excellent. Lowest yielding cultivars were the red cultivars Cimmaron, Rosalita, and Rouge d'Hiver, with extensive premature bolting.

In Crop 2, transplanted August 7-8, average yield of 13 cultivars at Windsor was 12,310 lb/A compared to 17,340 lb/A at Mt. Carmel (Table 4). Greater average yield at Mt. Carmel compared to Windsor was due to greater average percent harvested (73 vs. 45). Low average yield at Windsor was largely due to premature bolting in all cultivars except Ideal, Jericho, Kalura, Plato, and Romulus.

At Windsor, yield of Plato and Ideal exceeded 28,900 lb/A. Average weight of their heads was 1.6 lb and over 80% of heads were of marketable quality. Yields of Cimmaron, Rosalita, and Rouge d'Hiver were low because of excessive premature bolting.

At Mt. Carmel, average head weight in Crop 2 (1.1 lb) declined compared to Crop 1 (1.6 lb). Smaller heads were probably due to declining average daily temperature and day length. Yield of Kalura, Plato, Jericho, Ideal, and Romance exceeded 22,000 lb/A. Higher yield in these cultivars was due to above-average head weight and percent harvested.

Crop 3 was transplanted August 31 at both sites. This planting, later than normal, would test the cultivar's ability to produce a marketable crop in late October or early November. The average yield of 13 cultivars at Windsor was 10,500 lb/A compared to 17,360 lb/A at Mt. Carmel, a difference of 65%.

Declining average yield at Windsor in Crop 3 compared to Crop 2 was mostly due to plant response to sharply declining temperature at this inland site. All plants in this crop were free of tipburn and premature bolting but most heads failed to attain marketable size. At Mt Carmel, average yield in Crop 3 was similar to average yield in Crop 2 because fall temperatures decline slower in this coastal site influenced by Long Island Sound. Plato was the only cultivar to reach a marginal weight of 0.8 lb. Its yield exceeded 15,600 lb/A.

At Mt. Carmel, the average head weight of 13 cultivars was 1.1 lb, the same average head weight as in Crop 2. Most

cultivars produced marketable heads. Yield of Jericho, Plato, Olga, Verte Mar, Ideal and Romulus exceeded 20,000 lb/A and were of excellent quality. Tipburn and premature bolting were not observed on this late-planted crop whose harvest concluded November 1.

Looseleaf lettuce—Spring Crops 1997. In Crop 1, transplanted April 25-28, the average yield of seven cultivars of looseleaf lettuce was 21,900 lb/A at Windsor compared to 23,525 lb/A at Mt. Carmel, a 7% difference (Table 5). The average head weight at Mt. Carmel (1.1 lb) was slightly greater than at Windsor (1.0 lb) and accounted for the difference in yield.

At Windsor, Two Star had the greatest yield (26,140 lb/A) compared to all others. Its average head weight (1.2 lb) was greater than all others. Yield of Super Prize was about 24,000 lb/A. The quality of all cultivars was excellent.

At Mt. Carmel, Two Star had the greatest yield (27,460 lb/A) among all others by virtue of its heavy heads (1.3 lb). Yield of Salad Bowl, Royal Green, and Slo Bolt exceeded 23,000 lb/A. The quality of all cultivars was excellent, although minor tipburn symptoms were observed on 10% of Slo Bolt and Waldman's Dark Green.

In Crop 2, transplanted May 7-8, average yield of seven cultivars of looseleaf lettuce was 20,640 lb/A at Windsor compared to 20,710 lb/A at Mt. Carmel. Both average head weight and percent harvested were virtually the same at both sites.

At Windsor, yield of Salad Bowl and Simpson Elite exceeded 23,000 lb/A. Quality was reduced by symptoms of tipburn in all cultivars except Salad Bowl and Super Prize. The symptoms of tipburn were confined to newly forming leaves at the growing tip.

At Mt. Carmel, yield of Royal Green, Salad Bowl, Simpson Elite, and Two Star, exceeded 21,000 lb/A. Quality of all cultivars was excellent except Waldman's Dark Green and Slo Bolt which displayed symptoms of tipburn on 30-90% of heads.

Looseleaf lettuce—Fall Crops 1997. In Crop 1, transplanted July 21-22, the average yield of three cultivars of looseleaf lettuce common to both sites was 21,020 lb/A at Windsor compared to 13,915 lb/A at Mt. Carmel, a 51% difference (Table 6). At Mt. Carmel, average head weight was sharply reduced by droughty conditions (-1.7 inches of rain) in July compared to a greater-than-normal supply (+1.6 inches of rain) at Windsor. Among the five cultivars planted at both sites, Royal Green and Waldman's Dark Green bolted prematurely before the plants reached marketable size.

At Windsor, yield of Simpson Elite was greatest (24,500 lb/A) by virtue of its heaviest heads (1.1 lb) among all cultivars. The quality of Simpson Elite and Slo Bolt was excellent. Two Star developed tipburn on about 20% of its plants.

At Mt. Carmel, yield of Slo Bolt was greatest (15,250 lb/A), but small head size limited its commercial value. Only Two Star had heads of commercial value.

In Crop 2, transplanted August 5-9, the average yield of five cultivars of looseleaf lettuce was 20,540 lb/A at Windsor compared to 17,720 lb/A at Mt. Carmel, a difference of 16%.

At Windsor, yields of Two Star and Simpson Elite exceeded 21,000 lb/A with excellent quality. Yields of Waldman's Dark Green and Royal Green were lowest among all others because 57 and 33% of their plants bolted prematurely, respectively.

At Mt. Carmel, yield of Simpson Elite and Slo Bolt exceeded 21,000 lb/A. Simpson Elite had the heaviest heads (1.1 lb) and was of excellent quality. Premature bolting was excessive in Waldman's Dark Green (83%) and Royal Green (100%). Yield of Two Star was reduced by premature bolting in 23% of plants.

At both sites, tipburn did not develop because soil moisture was adequate in August and early September as the plants reached maturity.

In Crop 3, transplanted August 28-29, average yield of six cultivars of looseleaf lettuce was 22,160 lb/A at Windsor compared to 8,240 lb/A at Mt. Carmel, a difference of 160%. The average head weight at Windsor was 1.1 lb compared to 0.5 lb at Mt. Carmel. The low head weights of all cultivars at Mt. Carmel limited their commercial value.

At Windsor, the yield of Royal Green, Waldman's Dark Green, and Two Star exceeded 24,000 lb/A. The quality of all cultivars was excellent. Premature bolting or tipburn was not observed in this crop.

TIPBURN AND BOLTING

From the preceding section on yield of Romaine and looseleaf lettuce, it was apparent that yields of some cultivars in some plantings were reduced because of the physiological disorders tipburn and premature bolting. Because these disorders reduce yield and profit, let us look more closely at their impact related to cultivars, sites, and seasonal trends.

Tipburn. There is general agreement that tipburn is a physiological disorder that often occurs in lettuce plants nearing maturity. Marginal leaf necrosis occurs during periods of rapid growth when calcium-poor laticifers (latex producing cells) rupture during periods of high turgor pressure (Collier and Huntington 1983, Tibbets et al. 1985). Calcium deficiency occurs in the leaf margins because calcium mobility in the plant is relatively slow, and translocation cannot keep pace with tissue development during periods of rapid growth. Tipburn symptoms can appear under varied conditions, i.e. increased transpiration, excess soil moisture, deficient soil moisture, high light intensity, and excessive soil nitrate (Shear 1975). Low or high soil moisture and excessive soil nitrate affects the

Table 6. Yield of looseleaf lettuce at Windsor and Mt. Carmel, Fall 1997.

	WINDSOR				MT. CARMEL			
	Heads hvst.	Avg. wt.	Total yield		Heads hvst.	Avg. wt.	Total yield	
Cultivar	%	lb.	lb/A	Cartons/A	%	lb.	lb/A	Cartons/A
CROP 1		(Planted July 22)				(Planted July 21)		
Looseleaf								
Royal Green	0[y]				0[y]			
Salad Bowl	-	-	-	-	90	0.6	11,760a	0[z]
Simpson Elite	100	1.1	24,500a	908	100	0.6	13,070a	0[z]
Slo Bolt	100	0.9	19,600b	908	100	0.7	15,250a	0[z]
Two Star	87	1.0	18,950b	800	77	0.8	13,420a	699
Waldman's Dk. Grn.	0[y]				0[y]			
CROP 2		(Planted August 9)				(Planted August 5)		
Looseleaf								
Royal Green	67	1.0	14,590b	608	0[y]			
Salad Bowl	100	0.9	19,600ab	908	83	0.7	12,650b	0[z]
Simpson Elite	100	1.0	21,780a	908	100	1.1	23,960a	908
Slo Bolt	97	0.9	19,010ab	881	97	1.0	21,130a	881
Two Star	100	1.0	21,780a	908	67	0.9	13,130b	608
Waldman's Dk. Grn.	43	1.0	9,360c	390	0[y]			
CROP 3		(Planted August 29)				(Planted August 28)		
Looseleaf								
Royal Green	97	1.4	29,580a	881	90	0.6	11,760a	0[z]
Salad Bowl	90	0.8	15,680c	817	57	0.5	6,210b	0[z]
Simpson Elite	93	0.9	18,230c	844	83	0.3	5,420b	0[z]
Slo Bolt	97	0.9	19,010bc	881	83	0.3	5,420b	0[z]
Two Star	93	1.2	24,310b	844	73	0.5	7,950ab	0[z]
Waldman's Dk. Grn.	100	1.2	26,140ab	908	97	0.6	12,680a	0[z]

[v] Based on 1'x 2' spacing or 21,780 plants/A.
[w] Mean separation within columns for each crop by Tukey's HSD multiple comparison test at P=0.05. Values in columns followed by the same letter in each crop did not differ significantly.
[x] Based on standard 25 lb. - 24 count cartons.
[y] All bolted prematurely.
[z] Heads less than 0.8 lb. have little commercial value.

ability of plant roots to absorb calcium. Control of tipburn through application of calcium in foliar sprays and addition of calcium to the soil is a doubtful remedy (Ryder 1979). Withholding moisture or nutrients to slow growth also reduces yield. Avoidance of light (sandy) soils that warm readily in summer and promote rapid growth may offer some control if alternative sites with heavier soils are available. It is known, however, that some cultivars of lettuce translocate calcium more efficiently than others and resist the development of tipburn. Selection of cultivars appears to be the most likely choice to avoid tipburn.

The incidence of tipburn in the 1996 spring and fall crops of Romaine lettuce at Windsor and Mt. Carmel is shown in Table 7. It is abundantly clear that Romaine grown in the sandy soil of Windsor with limited moisture holding capacity is more prone to development of tipburn than Romaine grown in the loamy soil of Mt. Carmel with moderate moisture holding capacity. At Windsor, the moisture deficit in June followed by sudden rains in early July was largely responsible for its development in spring Crop 1. The moisture deficit in August followed by abundant rain in September also contributed to its development in Fall Crops 1 and 2.

At Mt. Carmel, tipburn was not as abundant in all spring and fall crops. Its greatest expression was in fall Crop 2. At both sites, the cultivars Jericho, Kalura, Plato, and Romulus were more prone to tipburn than all others. The red cultivars, Cimmaron, Rosalita, and Rouge d' Hiver were tipburn-free

Table 7. Number of Romaine lettuce plants affected by tipburn in two spring and three fall plantings at Windsor and Mt. Carmel, 1996. Each cultivar is represented by 30 plants in each crop.

	WINDSOR				
	SPRING		FALL		
Cultivar	Crop 1	Crop 2	Crop 1	Crop 2	Crop 3
Cimmaron	2	0	0	0	0
Green Towers	4	-	3	5	0
Ideal	-	-	4	1	0
Jericho	11	-	3	13	0
Kalura	9	-	3	17	0
Olga	0	1	0	12	0
Parris Island	0	-	6	5	0
Plato	15	-	5	5	0
Romance	3	-	5	0	0
Romulus	28	-	6	2	0
Rosalita	0	-	0	0	0
Rouge d'Hiver	0	-	0	0	0
Verte Mar	4	-	3	1	0
	MT. CARMEL				
Cimmaron	0	0	0	0	0
Green Towers	0	0	0	2	0
Ideal	1	0	0	1	0
Jericho	6	0	0	9	0
Kalura	4	0	0	7	0
Olga	0	0	0	2	0
Parris Island	0	0	0	0	0
Plato	5	7	0	5	0
Romance	0	0	0	0	0
Romulus	0	1	0	2	0
Rosalita	0	0	0	1	0
Rouge d'Hiver	0	0	0	0	0
Verte Mar	0	0	0	6	0

Table 8. Number of looseleaf lettuce plants affected by tipburn in two spring and three fall plantings at Windsor and Mt. Carmel, 1997. Each cultivar is represented by 30 plants in each crop.

	WINDSOR				
	SPRING		FALL		
Cultivar	Crop 1	Crop 2	Crop 1	Crop 2	Crop 3
Royal Green	0	6	0	0	0
Salad Bowl	0	0	-	0	0
Simpson Elite	0	6	0	0	0
Slo Bolt	1	26	0	0	0
Super Prize	0	0	-	-	-
Two Star	0	3	10	0	0
Waldman's Dk. Green	0	23	0	0	0
	MT. CARMEL				
Royal Green	0	3	0	0	3
Salad Bowl	0	0	0	0	0
Simpson Elite	0	1	0	0	1
Slo Bolt	2	10	0	8	0
Super Prize	0	0	-	-	-
Two Star	0	3	0	0	0
Waldman's Dk. Green	3	29	0	0	0

Table 9. Number of plants of Romaine lettuce that prematurely bolted in two spring and three fall plantings at Windsor and Mt. Carmel, 1996. Each cultivar is represented by 30 plants in each crop.

	WINDSOR				
	SPRING		FALL		
Cultivar	Crop 1	Crop 2	Crop 1	Crop 2	Crop 3
Cimmaron	4	30	8	26	0
Green Towers	0	0	25	13	0
Ideal	0	0	0	3	0
Jericho	0	0	0	0	0
Kalura	0	0	0	0	0
Olga	0	0	0	15	0
Parris Island	0	0	24	9	2
Plato	0	0	2	3	0
Romance	0	0	13	10	0
Romulus	0	0	10	2	0
Rosalita	4	14	21	24	0
Rouge d'Hiver	2	7	23	24	0
Verte Mar	0	0	25	19	0
	MT. CARMEL				
Cimmaron	2	20	20	13	0
Green Towers	0	0	0	17	0
Ideal	0	1	0	0	0
Jericho	0	0	0	0	0
Kalura	0	0	0	0	0
Olga	0	0	0	4	0
Parris Island	0	0	16	6	0
Plato	0	0	0	1	0
Romance	0	0	15	1	2
Romulus	0	0	5	1	0
Rosalita	5	14	22	19	0
Rouge d'Hiver	4	18	23	6	0
Verte Mar	0	10	6	3	0

because they bolted prematurely. Among all green cultivars, Ideal and Romance were least prone to tipburn.

The incidence of tipburn in the 1997 spring and fall crops of looseleaf lettuce at Windsor and Mt. Carmel is shown in Table 8. The development of tipburn was less site specific in 1997 than in 1996. Its greatest expression was in spring Crop 2 at both sites, caused by moisture deficits in June.

In spring Crop 2, Slo Bolt and Waldman's Dark Green developed tipburn in 75-90% of all plants at both sites. In all fall crops at both sites, the development of tipburn was minor because of abundant rainfall in August. Among all cultivars, Salad Bowl was completely free of tipburn in all spring and fall crops at both sites. The incidence of tipburn was also low in Royal Green, Simpson Elite, and Two Star in all crops at both sites.

Bolting. Because the lettuce plant is an annual, it is destined to bolt during the growing season. Hopefully, the plant will not begin to form a seed head before it reaches marketable size.

Premature bolting is often a problem in lettuce production. Bolting occurs when the plant shifts from the vegetative to the reproductive stage. The propensity to bolt is established early in the life cycle of the plant. Germinating seeds can become vernalized if exposed to low temperatures and bolting commences after the plant is exposed to increased day length. Seedlings lose their ability to vernalize after they reach the 1-3-leaf stage (Weibe 1989). Since some cultivars of lettuce are more easily vernalized than others, selection of cultivars has been used to minimize the problem.

Bolting of Romaine in 1996 spring and fall crops at Windsor and Mt. Carmel is shown in Table 9. Premature bolting at both sites in spring Crops 1 and 2 did not occur in most cultivars. Premature bolting in the red cultivars, Cimmaron, Rosalita, and Rouge d' Hiver was light in Crop 1 and extensive in Crop 2 at both sites.

In fall Crops 1 and 2, premature bolting occurred in 30-80% of plants in 9 of 13 cultivars in Windsor and 6 of 13 cultivars at Mt. Carmel. Fall Crops 1 and 2 were germinated

Table 10. Number of plants of looseleaf lettuce that prematurely bolted in two spring and three fall plantings at Windsor and Mt. Carmel, 1997. Each cultivar is represented by 30 plants in each crop.

	WINDSOR				
	SPRING		FALL		
Cultivar	Crop 1	Crop 2	Crop 1	Crop 2	Crop 3
Royal Green	0	0	29	10	0
Salad Bowl	0	0	-	0	0
Simpson Elite	0	0	0	0	0
Slo Bolt	0	0	0	0	0
Super Prize	0	0	-	-	-
Two Star	0	0	4	0	0
Waldman's Dk. Green	0	0	30	17	0
	MT. CARMEL				
Royal Green	0	0	24	26	0
Salad Bowl	0	0	0	4	0
Simpson Elite	0	0	0	0	0
Slo Bolt	0	0	0	0	0
Super Prize	0	0	-	-	-
Two Star	0	0	7	10	0
Waldman's Dk. Green	0	0	27	30	0

in a cold frame and held there in late-July through early-August, a time when temperatures were high and daylight was long. These two factors combined to vernalize the seedlings, causing the onset of premature bolting in some cultivars (Rappaport and Wittwer 1956). Among all cultivars of Romaine tested, Ideal, Jericho, Kalura, and Plato resisted vernalization and are probably day-neutral. Fall Crop 3 was planted in late-August as temperatures decreased and day length shortened. It is obvious that vernalization did not occur and the plants did not bolt prematurely.

The incidence of premature bolting in the 1997 spring and fall crops of looseleaf lettuce followed much the same pattern as Romaine in 1996 (Table 10). Premature bolting did not occur in spring Crops 1 and 2, and fall Crop 3. Extensive bolting occurred in fall Crops 1 and 2 at both sites but was confined to Royal Green and Waldman's Dark Green. In 1997, fall Crops 1 and 2 were planted at the same time as in 1996, when temperatures were high and daylight hours long. Salad Bowl, Simpson Elite, Slo Bolt, and, to some extent, Two Star, resisted premature bolting and are probably day-neutral.

MATURITY

Maturity of Romaine and looseleaf lettuce is important in scheduling planting for harvest at a specific time. Days to maturity, reported in seed catalogues, is generally calculated from the seeding date to the date of harvest. The numbers reported are an average over many site conditions and acquired genetic characteristics. Since all of my test crops were from transplanted seedlings rather than direct seeding in the field, I divided maturity into two elements, days from seeding to 4-inch transplants, and days from transplanting to harvest. The days to maturity from seeding to harvest is dependent upon day length and temperature as noted in broccoli and cauliflower (Hill 1989) and crisphead lettuce (Hill 1993).

For production of Romaine and looseleaf lettuce transplants, 6-7 weeks were required to produce a 4-inch transplant in April and May and about 5 weeks in July and early August.

As day length and temperature increase, total maturity shortens 4-5 weeks for Romaine lettuce and 3 weeks for looseleaf lettuce in July and August plantings compared to earlier and later plantings (Table 11). Although maturity among the array of cultivars of Romaine and looseleaf lettuce was controlled, to a great extent, by day length and temperature, differences were noted among cultivars that are due to genetic characteristics. Romaine lettuce cultivars, Cimmaron, Rosalita, and Rouge d'Hiver matured 5 days earlier than average while Green Towers, Ideal, Plato, and Romulus matured about 5 days later than average. For looseleaf lettuce, all cultivars matured at the same time.

HARVEST SPAN

Uniformity of maturity can be measured by the harvest span which I define as the number of days it takes to harvest at least 90% of the crop. Both spring and fall crops of Romaine and looseleaf lettuce matured evenly. At Windsor and Mt. Carmel, all plants of each cultivar of Romaine and looseleaf lettuce were harvested on the same day. This was

Table 11. Average days to maturity among all cultivars of Romaine and looseleaf lettuce in spring and fall plantings at Windsor and Mt. Carmel 1996-1997.

	1996-Romaine			1997-Looseleaf		
Seeding Date	Seed to transplant	Transplant to harvest	Total	Seed to transplant	Transplant to harvest	Total
March 12	50	55	105	45	45	90
March 26	48	45	102	42	47	89
June 16-18	31	38	69	35	33	68
July 1-2	36	42	78	38	34	72
July 22-24	40	63	103	36	55	91

unlike the maturity of crisphead lettuce which required a second harvest 2-6 days following the first harvest.

MANAGEMENT STRATEGIES

Transplanting vs. direct seeding. Transplanting of seedlings has several advantages over direct seeding for crop establishment. First, a more uniform stand can be established. The germination of seeds in the field can be erratic and is dependent upon available moisture in the soil, light, and temperature. Lettuce seeds require light during the induction phase of germination (Ryder 1979). If planted too deeply, germination may be inhibited. Uniform germination requires a carefully prepared seed bed. Second, fields that are transplanted require less time for growing the crop, and harvest can usually be reduced to a single event. Finally, transplanting eliminates the need for expensive thinning. This expense, however, must be weighed against the costs of producing or buying transplants and careful preparation of a uniform seed bed.

Planting dates. From the array of planting dates tested for spring and fall harvest, it is apparent that Romaine grown for spring harvest assures greater yields. Among all cultivars grown, the average yield in spring crops was 11,600 lb/A greater at Windsor and 5,500 lb/A greater at Mt. Carmel than the average yield of all cultivars grown in fall.

For looseleaf lettuce, average yields in spring and fall were virtually the same at both sites (21,200 lb/A). At Windsor, however, average yield of all cultivars in spring was 8,900 lb/A greater in spring than in fall.

Greater yields of Romaine lettuce in spring at both sites was undoubtedly due to the lack of bolting that plagued the fall crops and reduced yield. Several Romaine cultivars, transplanted in late July and early August for fall harvest, bolted. Tipburn, which reduces quality of Romaine and looseleaf lettuce, can develop in either spring or fall plantings and is highly dependent upon soil moisture content and weather at the time the crop is nearing maturity. Tipburn was most prevalent in spring Crop 1, planted in late-April 1996, and fall Crops 1 and 2, planted in late July and early August 1996. In 1997, looseleaf lettuce spring Crop 2, planted in early-May, was most affected. Its occurrence, therefore, is unpredictable.

The span of desirable planting dates in spring and fall is rather narrow. Suitable Romaine and looseleaf lettuce crops were grown with spring planting dates between April 25 and May 14. In fall, transplanting dates between July 18 and August 15 are the most reliable, but in coastal areas, the probability of producing a marketable crop is high in plantings up to September 1. Transplanting from mid-May to mid-July would be more speculative due to increased probability of premature bolting and development of tipburn. In 1998, however, successful crops of Romaine were grown in mid-summer plantings on soils amended with leaf compost and the plants mulched with undecomposed leaves (unpublished data). Plantings at this time should be confined to cultivars that are day-neutral and with known resistance to tipburn.

Selection of cultivars. The selected cultivars of Romaine and looseleaf lettuce are judged on yield (lb/A) and quality (resistance to premature bolting and tipburn). These judgments are based on observations for 1 year only for each lettuce type. Yield and quality may change from year to year due to variations in weather during their development in the field.

Romaine lettuce. For spring production, yield and quality were above average for Green Towers, an erect, semi-heading variety with dark green leaves. It was somewhat resistant to tipburn and premature bolting in spring plantings. Although yields were average, quality of Olga, an erect, heading type with tender, medium green leaves, was superior to all others. In spring plantings, Olga was resistant to tipburn and premature bolting. On about 10% of transplants, the stem divided during early growth, forming two smaller heads. Kalura and Jericho, virtually identical in appearance, were erect, open headed with light green slightly savoyed (crinkled) leaves. Both had excellent yields but were moderately susceptible to tipburn but resistant to premature bolting.

For fall production of Romaine lettuce, yield and quality

of Ideal, an erect, semi-heading type with smooth, medium green leaves was superior to all others. In fall, Ideal was resistant to tipburn and premature bolting. The seeds did not arrive in time for spring plantings, but its resistance to tipburn and premature bolting in fall suggests that it might be suitable for spring planting as well. Yield and quality of Plato, an erect, loose-headed type with medium green, slightly savoyed leaves, was above average for all fall plantings. In fall, Plato was slightly susceptible to tipburn but resistant to premature bolting. Again, the yield of Olga was average but its quality was excellent in two of three fall plantings at both sites.

Looseleaf lettuce. For spring production, Two Star had above-average yield and quality in three of four plantings. Its somewhat coarse, dark green leaves, form an open head. In spring, Two Star was resistant to tipburn and bolting. Simpson Elite also had above-average yield and quality in spring crops. Its light green leaves are savoyed and form a large open head. Resistance to bolting was observed in all spring crops and resistance to tipburn in three of four crops. Yield and quality of Royal Green was above average in all spring crops at Mt. Carmel. Its dark green, slightly savoyed leaves form a loose head. Although this cultivar was resistant to premature bolting in all spring crops, it was resistant to tipburn in the loamy soils at Mt. Carmel but moderately resistant in the sandy soils at Windsor.

For fall production, Simpson Elite, described earlier, had above-average yields and quality. In fall, Simpson Elite was resistant to tipburn and premature bolting. Although yield of Salad Bowl was below average in all fall crops, its quality was above average because it was resistant to tipburn and premature bolting. Its medium green, savoyed leaves form an open rosette. The leaves are tender, which precludes long distance shipping. Its best use is for sales at roadside stands.

Site selection. In 1996, average yield of all cultivars of Romaine lettuce was 3,350 lb/A greater in all spring crops and 1,830 lb/A greater in all fall crops in the loamy soil at Mt. Carmel compared to the sandy soil at Windsor. Because Windsor's sandy soil held less water for crop utilization than the loamy soil at Mt. Carmel, periods of drought were responsible for yield loss by tipburn and premature bolting.

In 1997, average yield of looseleaf cultivars in all spring crops was 850 lb/A greater in the loamy soil at Mt. Carmel compared to the sandy soil at Windsor. In contrast, the average yield of all looseleaf cultivars in all fall crops was 7,950 lb/A greater in the sandy soil at Windsor compared to the loamy soil at Mt. Carmel. This was largely due the failure of Crop 3 at Mt. Carmel to reach marketable size despite adequate soil moisture and sidedressing of nitrogen.

It is apparent that the sandy soil required more irrigation than was applied to maintain stress-free conditions and reduce the incidence of tipburn. Moisture stress was difficult to assess because the Romaine and looseleaf lettuce crops in 1996 and 1997 wilted little during droughty periods.

Use of cultivars that are resistant to tipburn and premature bolting are obvious choices in sites with sandy soils. The moisture holding capacity of a sandy soil can be improved with annual additions of organic matter.

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