The Connecticut Agricultural Experiment Station, New Haven

Cauliflower and Broccoli Trials 1987

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Bulletin 857

May 1988

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The popularity of broccoli and cauliflower continues as consumers take advantage of their nutritional benefits (Anon. 1971). Most western states that grow broccoli year round have increased their acreages of these two cole crops (Anon. 1985). Many eastern and north central states have joined the broccoli and cauliflower band wagon and have increased their acreages dramatically.

Two supermarket chains in Connecticut who have actively sought locally grown broccoli, continue their interest by participating in the "Broccoli Project". In 1985, the Connecticut Department of Agriculture enlisted five growers who grew a fall crop on 8 acres. In 1986, 13 growers raised 61 acres. In 1987, four growers planted 11 acres in spring for the first time and 18 growers planted 79 acres for a fall harvest.

The Connecticut Agricultural Experiment Station's role in the Project was testing cultivars (cultivated varieties) from domestic companies to determine those best suited to Connecticut's soil and climate. In 1985 I tested 32 broccoli cultivars and found seven in the spring and five in the fall that produced high quality heads (Hill 1986). In 1986, I retested 13 promising broccoli cultivars from 1985 trials and added six new cultivars and seven experimental varieties from California. Six cultivars in spring and 11 cultivars, including four experimentals, in fall (Hill 1987) met national quality standards for commercial production (Anon. 1943). The 1986 trials also included serial planting in fall to determine the breadth of harvest for the fall crop and maintenance of quality of preferred cultivars throughout the harvest period.

In 1987, I retested eight preferred cultivars from 1985 and 1986 trials and added 10 new cultivars including seven from Europe. The 1987 trials also included serial planting of two crops in spring and three crops in fall.

Because of discussion about a comparison "Cauliflower Project" in 1986, I tested 10 cauliflower cultivars in spring and 17 cultivars including two experimentals in fall. Five cultivars in spring and four cultivars in the fall, including one experimental, consistently produced high quality heads, called curds.

In 1987 I tested 29 cultivars including five promising cultivars retested from 1986. I also tested four early maturing cultivars in two serial plantings in the fall to determine the breadth of harvest and maintenance of quality.

From 1985 and 1986 trials, I have found that retesting of cultivars is important. Temperature and rainfall vary from year to year and quality of some cultivars may vary. We seek those cultivars that perform well under the ranges of climatic conditions in Connecticut.

In this bulletin I report yields, quality, and maturity of cauliflower and broccoli cultivars grown at Windsor and Mt. Carmel in the spring and fall of 1987.

SITES AND MANAGEMENT

The cauliflower and broccoli trials 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 a moderate moisture holding capacity.

The seed for the first planting of the spring crop was planted in a greenhouse with vents opened at 70F and heated when the

temperature fell below 50F. The seedlings were moved to a cold frame for hardening 2 weeks before they were transplanted in the field. For the spring crop, second plantings were made 2 weeks after the first planting of the broccoli cultivars Dandy Early, Galaxy, Green Comet, Premium Crop, Southern Comet, and Symphony. Early Emerald and Packman were also added to the second planting to avoid premature buttoning, which occurred in the first crop of our trials in spring 1986. A second planting of cauliflower cultivars Polar Express and White Knight was also made.

Seed for the fall crop was germinated in a greenhouse and moved outside after 1 week. Seedlings were transplanted when they were 4 inches high. In fall, second and third plantings were made of broccoli cultivars Cruiser, Emperor, Galaxy, Green Belt, Green Valiant, Packman, and Symphony. Second plantings were also made of early maturing cauliflower cultivars Andes, Polar Express, White Knight, and White Summer. Seeds for all second and third crops were sown and transplanted at 2-week intervals following the seeding and transplanting of the first crop.

The seedlings were grown in Promix BX in standard plastic pots measuring 2-5/8 in. x 2-1/4 in. x 2-5/16 in. and held in packs of 36. Water soluble 20-20-20 fertilizer (one tbsp/gal) was added to the seedlings 3 to 4 weeks after germination. The seedlings were transplanted in rows 36 in. apart with spacing 18 in. within rows to provide 9680 plants/A. Each planting consisted of five randomized blocks with six plants per cultivar in each replication. Transplanted seedlings that died the first week were replaced. Rabbits damaged numerous plants in the spring broccoli trials. Damaged plants were replaced and the trial area was fenced to avoid further predation.

The soil in both the spring and fall crops of cauliflower was treated with 5 lbs. soluble boron/A one month following transplanting to prevent hollow stem and browning of the curds, commonly observed during the 1986 cauliflower trials. Boron, dissolved in water, was sprayed on the soil surrounding the plants.

In spring, leaves of cauliflower were tied around the newly developing heads when they reached about 2 inch diameter. In the fall, leaves of all plants producing 2-inch curds were tied before October 1. After October 1 leaves of "self-blanching" cultivars were not tied because the inner leaves remain tightly furled about the curd.

Mature heads of broccoli and cauliflower were harvested at 3-day intervals. Yields of broccoli were weighed and the quality was judged for color, evenness and compactness of head, excessive stalkiness, and leaves protruding from the head. The quality of cauliflower was judged for size, color, smoothness of curd, and protection of the curd by surrounding leaves of self-blanching types.

Details of management of soil and crops and pertinent dates are listed in Table 1.

CHARACTERISTICS OF QUALITY

The characteristics of cauliflower and broccoli used to judge marketability in Tables 2,3,5, and 6 require definition.

CAULIFLOWER

Size of curd. Curd diameters follow national quality standards for cauliflower. They are large (lg) 7 inch or more; medium (med) 5 to 6-7/8 inch; small (sm) 3-1/2 to 4-7/8 inch; and very small (vsm) less than 3-1/2 inch. Where two classes are listed, both are co-dominant. Other classes may constitute less than 20% of the heads.

Rough curd. Individual branches within the curd may develop more rapidly than others and create an uneven surface. Rough curds are less appealing to the eye.

High domed. Individual branches within the curd are of equal length and create a highly convexed shape with a flat base. If the curd stalk is small, the curd is almost ball shaped. Both of these shapes have appealing uniformity.

Ricey curd. The flower parts form prematurely and elongate, creating a soft velvety appearance.

Color. Curd color should be white or creamy white. Curds become yellow if exposed to sunlight. Reddish and brownish colors or water-soaked appearance generally indicate mineral deficiency or disease.

Leafy. Leaves that generally wrap around

the developing head protrude from the curd.

Button. Buttoning is the formation of the curd while the plant is small. This is caused by vernalization or chilling of the seedlings. The curd is only about 1 to 2 inch wide. Buttoning was observed mostly on early maturing cultivars in the spring trials.

BROCCOLI

Size of head. Head diameters follow national quality standards for broccoli. They are very large (vlg) 7 inch or more; large (lg) 5 to 6-7/8 inch; medium (med) 3-1/2 to 4-7/8 inch; small (sm) less than 3-1/2 inch. Where two size classes are listed, both are co-dominant. Other size classes may constitute less than 20% of the heads.

Leafy. Leaves usually grow on the stalk below the head but extend around and above the head. A leafy head has small to medium sized leaves protruding through the head.

Lumpy. A lumpy head is one in which portions of the head grow faster than others. This condition is more likely to develop on cultivars with long secondary branches forming the head. The uneven surface is less aesthetic. Depressions in lumpy heads may collect water and become focal points for bacterial rot. Short secondary branches within the head create a high domed head whose uniformity is appealing.

Color. Dark green to bluish green heads are preferred. A purplish cast, generally caused by cold in the the fall crop, does not

TABLE 1--SOIL AND CROP MANAGEMENT OF CAULIFLOWER (C) AND BROCCOLI (B) AND PERTINENT DATES.

Activity			Spring crop	Fall Crop
Soil fertilization (Rates based on soil tests)				
10-10-10		B,C	1300 lbs/A	1300 lbs/A
lime		B,C	None	None
soluble Boron		C	5 lb/A	5 lb/A
(Applied to soil 1 month after transplanting)				
Planting Dates				
Seeding in greenhouse	1st Crop	B,C	March 12-16	June 18-21
or outdoor enclosure	2nd Crop	B,C	March 27-31	July 7
	3rd Crop	B	-	July 19
Transfer to cold frame	1st Crop	B,C	April 8-10	-
	2nd Crop	B,C	April 24	-
Transplant seedlings	1st Crop	B,C	April 21-27	July 15-22
to field	2nd Crop	B,C	May 5-8	Aug 1
	3rd Crop	B	-	Aug 17-18
Pest Control				
Root maggots		B,C	Lorsban 4E	Lorsban 4E
Cabbage worms		B,C	Pydrin 2.4E	-
Flea beetles on seedlings		B,C	-	Sevin
Irrigation				
Windsor		B,C	1	4
Mt. Carmel		B,C	1	3
Weed Control				
Cultivations		B,C	2	2

affect marketability. Pale green, yellowish, and reddish colors indicate mineral deficiencies, disease, or overmaturity. Brown, black, or water soaked patches indicate disease.

Brown beading (Br. Bead). Yellow flecks turning brown on a maturing head is the decay of undeveloped florets within the head. High temperatures during maturity of the head is thought to be the cause of this symptom.

Corky stem. The external part of the stem cracks and produces light brownish scars. This symptom is thought to be caused by boron deficiency.

Exerted heads. The head is on a stalk that rises above the main body of leaves. Cultivars with well-exerted heads have been developed for mechanical harvest.

YIELD AND QUALITY OF CAULIFLOWER

Spring crop. The average yield in spring of all cauliflower cultivars at Windsor was 11,923 lbs/A compared to 10,137 lb/A at Mt. Carmel, a difference of 15%. The higher average yields at Windsor are consistent with 1986 trials. Andes, Candid Charm, Taipan and White Fox had highest yields at both sites with 7.0 to 9.7 tons/A (Table 2). Fifteen of 30 cultivars at both sites exceeded the national average of 5.4 tons/A (Anon. 1985). Among the 15 cultivars with high yields, ten had consistently good quality. Candid Charm, a self-blanching type, had dense medium-sized curds averaging 2.3 lbs. Other self-blanching types such as Cloud Nine, Taipan, White Fox, White Rock, White Sails, and White Summer had uniformly shaped white curds. Curd development in these cultivars was so rapid that wrapper leaves could not keep pace with the expanding head and required tying. Andes, Polar Express and White Knight with medium curds also required blanching. A second crop of Polar Express and White Knight was transplanted early in May at Windsor and Mt. Carmel. White Knight yielded 8.1 tons/A at Windsor and 4.8 tons/A at Mt. Carmel. In contrast, the yield of Polar Express at Mt. Carmel was 6.3 tons/A compared to 5.0 tons/A at Windsor. Despite variability in the size of curds of White Knight among sites, the quality was excellent at both sites.

The yields of other cultivars reported in Table 2 were below the national average at one or both sites. Cervina, Silver Star, and White Top had smooth curds but inconsistent size. Late maturing curds of Silver Star rotted. The experimental cultivars PSR 100184 and PSX 27885 with a high percent of buttoning are not suitable for spring planting.

Defects found in other cultivars are noted in Table 2.

Fall crop. All cultivars planted in the spring crop were repeated for the fall crop except PSR 277854 and PSX 27885, which had defects in the fall 1986 trials (Hill 1987). The average yield of all cultivars at Windsor was 15,308 lb/A compared to 14,292 lb/A at Mt. Carmel, a difference of only 7%. These average yields are equal to those at Windsor for 1986 (15,224 lb/A) and greater than the average yields at Mt. Carmel (12,631 lb/A). The yields of Andes, Candid Charm, White Cloud, White Fox, and White Sails exceeded 9 tons/A at Windsor and 7 to 8 tons/A at Mt. Carmel. The yields of virtually all cultivars at Windsor and Mt. Carmel exceeded the national average of 5.4 tons/A. The only exception was late maturing Olympus at Mt. Carmel, where 50% of the developing heads were frozen by temperatures below 15F on November 21 and 22. Late maturing cultivars of Cervina, Self-Blanche, Snowball Y Improved, and White Rock also suffered losses up to 15% at Mt. Carmel during these low temperatures. No losses by freezing occurred at Windsor because the harvest had been completed by November 9.

Cultivars with consistently high quality and high yields were Candid Charm, Cloud Nine, Polar Express, Snow King, Snow Pak, White Rock, White Top, and PSR 100184. Snow King matured in the shortest time, 50 days at Windsor and 56 days at Mt. Carmel. Its rapidly developing curd required blanching to ensure whiteness. Candid Charm, Cloud Nine, Snow Pak, White Rock, and White Top were excellent self-blanching types and did not require tying. Polar Express and White Knight, although surrounded by large upright leaves, required tying to insure whiteness. Other self-blanching cultivars with high quality

TABLE 2--YIELD AND QUALITY OF CAULIFLOWER AT WINDSOR AND MT. CARMEL, SPRING 1987.

	Windsor			Mt. Carmel			
Cultivar	Curds Hvst. %	lb	Avg. Curd lb/A	Total Yield %	Curds Hvst. lb	lb/A	Avg. Curd Size and quality of curd / Total Yield
Andes*	90	1.9	16294	97	1.5	13984	med, uniform
Candid Charm*	87	2.3	19475	100	1.4	13875	med, uniform, self-blanch
Cervina	97	1.6	14591	83	1.1	9119	med, variable, exerted
Cloud Nine*	97	1.7	15845	97	1.4	13012	med, uniform, dense ball-shaped
Early White	90	0.8	6897	93	0.7	5968	sm, loose, very early
Imperial	70	1.3	8692	97	1.0	9167	med, rough, variable
Linas	93	1.6	14307	97	1.3	12546	med, variable, exerted
Olympus	73	1.5	10579	47	1.2	5524	med, loose, leafy
Polar Express*	93	1.5	13664	100	1.3	12302	med, smooth, uniform
PSR 100184	53	1.4	7415	73	1.2	8813	med, leafy, ricey, variable
PSX 27885	53	0.4	1844	50	0.2	1089	vsm, buttoned
Raket	77	0.8	6117	97	0.7	6840	med, smooth, variable
Self-Blanche	87	1.3	10770	90	1.0	9055	med, rough, loose
Silver Star	87	1.7	14454	90	1.2	10406	med, variable, late head rot
Snowball Y Imp.	80	1.4	11031	87	1.2	10446	med, leafy, ricey
Snowball 741	67	1.6	10052	93	1.0	9324	med, leafy, ricey
Snow Crown	97	1.2	11049	97	1.0	9127	med, rough, purple tinge
Snow Flower	77	1.4	10431	80	0.9	7280	med, leafy, rough
Snow King	57	0.4	2150	60	0.3	1573	sm, smooth, buttoned
Snow Pak	90	1.7	14984	97	1.5	13842	med, variable
Taipan*	97	1.7	16290	100	1.5	14460	med, dense, smooth, self-blanch
White Castle	80	1.7	13390	87	1.6	13462	med, dense, rough
White Fox*	97	1.7	16087	97	1.5	14165	med, dense, ball-shaped, self-blanch
White Knight*	93	1.3	11896	97	1.0	9349	med, smooth, uniform
White Rock*	77	1.8	13388	83	1.4	11087	med, dense, ball-shaped, self-blanch
White Sails*	97	1.6	14671	97	1.4	13132	med, smooth, uniform, self-blanch
White Summer*	83	1.7	13438	97	1.2	11575	med, smooth, uniform, self-blanch
White Top*	97	1.4	13559	93	1.2	11173	med, variable
XPH 5105	93	1.1	9927	100	1.1	10245	med, rough, variable, leafy
Second Crop							
Polar Express*	80	1.3	10023	100	1.3	12644	med, smooth, uniform
White Knight*	90	1.9	16315	97	1.0	9673	med, smooth, variable

*Cultivars produced high quality heads at both Windsor and Mt. Carmel.

TABLE 3--YIELD AND QUALITY OF CAULIFLOWER AT WINDSOR AND MT. CARMEL, FALL 1987

	Windsor			Mt. Carmel			
Cultivar	Curds Hvst. %	lb	Avg. Curd lb/A	Total Yield %	Curds Hvst. lb	Avg. Curd lb/A	Size and quality of curd
Andes*	97	2.0	18455	100	1.6	15891	med, dense, uniform
Candid Charm*	93	2.1	18768	93	1.8	16196	med, dense, self-blanch
Cervina	93	1.6	13966	80	1.6	12241	med, uniform, self-blanch, late
Cloud Nine*	93	1.9	16940	100	1.5	14964	med, smooth, self-blanch
Early White	100	1.5	14197	100	1.5	14964	med, loose
Imperial	70	1.8	12241	77	1.6	12092	med, leafy, hollow stem variable
Linas	87	1.7	14050	93	1.5	13945	med, exerted, ball-shaped, variable
Olympus	83	1.6	12493	50	1.4	6594	med, leafy, ricey, late
Polar Express*	83	1.8	14643	93	1.5	13744	med, smooth, uniform
PSR 100184*	90	1.8	15690	100	1.7	16254	med, dense, uniform, self-blanch
Raket	100	1.6	15710	90	1.6	14258	med, variable
Self-Blanche	80	1.4	11092	83	1.6	13116	med, dense, self-blanch, late
Silver Star	73	1.7	12286	87	1.6	13200	med, dense, ball-shaped, self-blanch
Snowball Y Imp.	87	1.7	13948	77	1.7	12800	med, leafy, ricey, hollow stem, late
Snowball 741	73	1.9	13269	73	1.6	11182	med, leafy, ricey, variable, late
Snow Crown	90	1.9	16436	100	1.7	16597	med, dense, smooth, purple tinge
Snow Flower	73	1.7	12346	77	1.6	12092	med, leafy, curd rot, late
Snow King*	97	1.4	13598	100	1.4	13955	med, smooth, uniform, very early
Snow Pak*	80	1.6	12766	87	1.8	14961	med, dense, smooth, self-blanch
Taipan	97	1.8	17059	100	1.5	14782	med, dense, smooth, exerted
White Castle	77	2.1	15312	93	2.0	17824	med, hollow stem, self-blanch
White Cloud	93	2.1	18808	100	1.8	17626	med, dense, smooth, self-blanch
White Fox	100	1.9	18412	100	1.5	14560	med, smooth, uniform, exerted
White Knight*	100	1.7	16718	100	1.6	15105	med, smooth, uniform
White Rock*	87	2.0	16863	90	1.7	15085	med, dense, uniform, self-blanch
White Sails	93	2.0	18126	93	1.8	15775	med, smooth, uniform
White Summer	100	1.8	17061	90	1.5	12987	med, smooth, uniform
White Top*	100	1.8	17081	90	1.7	14742	med, dense, smooth, exerted, self-blanch
XPH 5105	97	1.6	15339	100	1.8	16980	med, smooth, uniform
Second Crop							
Andes*	100	1.5	14863	93	1.6	14227	med, dense, uniform
Polar Express*	97	1.6	15299	87	1.6	13847	med, dense, smooth, uniform
White Knight*	93	1.5	13865	80	1.5	11515	med, smooth, uniform
White Summer	93	1.0	9425	83	1.4	11027	med, smooth, uniform, late

*Cultivars produced high quality heads at both Windsor and Mt. Carmel.

TABLE 4--MATURITY OF CAULIFLOWER AT WINDSOR AND MT. CARMEL, SPRING AND FALL 1987

	Windsor				Mt. Carmel			
	Harvest Midpoint		Harvest Span		Harvest Midpoint		Harvest Span	
Cultivar	Spring Days*	Fall Days*	Spring Days**	Fall Days**	Spring Days*	Fall Days*	Spring Days**	Fall Days**
Andes	68	74	25	18	68	91	25	21
Candid Charm	64	74	14	10	64	87	14	17
Cervina	71	102	18	31	71	109	18	24
Cloud Nine	64	74	7	28	64	94	7	28
Early White	51	57	7	6	51	63	7	7
Imperial	61	84	13	31	61	105	13	21
Linas	68	89	7	32	68	105	7	11
Olympus	64	112	10	25	64	115	10	20
Polar Express	58	67	10	3	58	80	10	14
PSR 100184	64	98	21	20	64	101	21	14
PSX 27885	41	-	1	-	41	-	1	-
Raket	51	77	20	19	51	91	20	18
Self Blanche	68	102	24	21	68	105	24	34
Silver Star	71	98	18	35	71	108	18	14
Snowball Y Imp.	61	98	17	36	61	108	17	31
Snowball 741	61	95	17	28	61	105	17	34
Snow Crown	54	63	24	10	54	70	24	21
Snow Flower	61	95	21	35	61	112	21	20
Snow King	41	50	1	8	41	56	1	8
Snow Pak	68	105	17	14	68	105	17	14
Taipan	68	81	14	19	68	94	14	25
White Castle	64	74	13	10	64	91	13	14
White Cloud	-	77	-	14	-	94	-	28
White Fox	64	77	14	17	64	91	14	18
White Knight	58	70	24	19	58	83	24	21
White Rock	71	89	21	35	71	105	21	21
White Sails	64	70	17	22	64	91	17	21
White Summer	64	84	10	19	64	98	10	14
White Top	71	91	32	28	71	101	32	17
XPH 5105	68	74	18	10	68	87	18	28
Second Crop								
Andes	-	83	-	17	-	90	-	21
Polar Express	51	83	11	7	53	83	7	14
White Knight	55	83	17	17	49	83	10	14
White Summer	-	97	-	11	-	97	-	14

*Time from transplanting to midpoint of harvest.
**Time from start to finish of harvest.

curds were Self-Blanche, Silver Star and White Castle, but their size was more variable and the percent of harvested curds was somewhat lower in comparison to others.

Defects in other cultivars are listed in Table 3. Hollow stem, reported in the 1986 trials, was virtually eliminated in most cultivars by application of soluble boron. Hollow stem was noted in only a few curds and did not detract from their overall quality.

Four early maturing cultivars, Andes, Polar Express, White Knight, and White Summer were planted as a second crop on August 1, two weeks after the first crop was planted. Andes, Polar Express and White Knight yielded above the national average at Windsor and Mt. Carmel. The quality of the curds was excellent. All of these cultivars required tying to ensure whiteness. White Summer's rough curds were medium-size and less appealing compared to its first fall crop.

Maturity. Maturity of cauliflower is important to schedule planting for a specific harvest period. The days to maturity were calculated from the day of transplanting to the day when half the curds were harvested; i.e. the harvest date of the 15th curd from a population of 30 plants (Table 4). Among the 29 cultivars planted in spring, time to maturity was consistent at both sites, seldom varying more than 2 or 3 days. Maturity ranged from 41 to 71 days at Windsor and 37 to 74 days at Mt. Carmel. The low number of days to maturity for Snow King and PSX 27885 is abnormal due to severe buttoning. A later planting date when temperatures are warmer would probably have prevented buttoning in these cultivars.

In fall, time to maturity of the 29 cultivars planted was longer. The range in harvest midpoint was 50 to 112 days at Windsor and 56 to 115 days at Mt. Carmel. Cultivars with maturities exceeding 100 days planted for a fall crop in upland areas have high probabilities of frost damage. The increased maturity in fall compared to spring of cultivars at Windsor (20 days) and Mt. Carmel (30 days) was consistent with 1986 trials (Hill 1987).

Another facet of maturity is the span of harvest, which I define as the days between the harvest of the first and last marketable curd. Short harvest spans favor single harvests. The short harvest spans for Snow King and PSX 27885 were due to harvest of buttoned curds. In spring at Windsor, Cloud Nine, Early White and Linas had the shortest spans, only 6-8 days. In fall, Early White, Polar Express and Snow King had the shortest spans at Windsor and Mt. Carmel. Many cultivars at Windsor and Mt. Carmel had harvest spans in fall that exceeded 4 weeks. In spring, 3-week spans were common. This is particularly useful for growers who produce cauliflower for roadside markets and rely on multiple harvests to provide freshly picked produce for a long harvest span.

In spring, the average harvest span of all cultivars was 17 days at Windsor and 19 days at Mt. Carmel. In fall the harvest span increased slightly to 21 days at Windsor and 20 days at Mt. Carmel.

YIELD AND QUALITY OF BROCCOLI

Spring crop. The average yields of all cultivars planted in the first crop was 7,911 lb/A at Windsor compared to 7,576 lb/A at Mt. Carmel, a difference of 4%. At Windsor, Skiff yielded over 6.5 tons/A, but its heads were lumpy and quality was poor. Yields of Corvet, Cruiser, Green Defender, Neptune, and Premium Crop exceeded the national average of 4 tons/A. At Mt. Carmel, Green Defender yielded over 7.5 tons/A, but quality was poor due to lumpy and leafy heads. Yields of Corvet, Cruiser, Green Comet, Neptune, and Skiff also exceeded the national average.

Cultivars with high yields do not necessarily produce heads of good quality. Some high yielding cultivars have pronounced defects that affect marketability. These defects are listed in Tables 5 and 6.

Among the cultivars with high yields at Windsor and Mt. Carmel, only Cruiser, Green Comet and Premium Crop had high quality heads. The quality of Cruiser was outstanding with large uniform high-domed heads. The quality of Galaxy and Symphony was also excellent but yields were below the national average.

The average yield of all cultivars in the

second crop planted about 2 weeks after the first crop was 9034 lb/A at Windsor and 7773 lb/A at Mt. Carmel, a 14% difference. The cultivars selected for the second crop were those of high yield and quality from 1985 and 1986 trials (Hill 1986, 1987). Since Early Emerald and Packman showed a tendency to button in early plantings of 1986, their planting was intentionally delayed until the second crop. In the second crop at Windsor, five of eight cultivars exceeded the national average while at Mt. Carmel only three of eight exceeded it. Among those exceeding the national average, Galaxy, Packman and Symphony had excellent quality heads as did Green Comet, Premium Crop and Southern Comet but with lower yields. Dandy Early and Early Emerald had lumpy heads of poorer quality. The yields of the second crop of Galaxy and Southern Comet were higher than in the first crop. This suggests that a planting date closer to May 1 in the

TABLE 5--YIELD AND QUALITY OF BROCCOLI AT WINDSOR AND MT. CARMEL, SPRING 1987

	Windsor			Mt. Carmel			
Cultivar	Heads Hvst. %	Avg. Head lb	Total Yield lb/A	Heads Hvst. %	Avg. Head lb	Total Yield lb/A	Size and quality of heads
Corvet	97	1.2	11595	97	1.2	10908	lg-vlg, lumpy, br. bead
Cruiser*	87	1.0	8624	90	1.1	9216	lg, compact, uniform
Embassy	97	0.7	6962	100	0.7	6574	sm-med, compact, variable
Galaxy	87	0.5	4474	100	0.6	5727	sm, very early, compact
Green Comet*	100	0.8	7744	100	0.9	8510	med, compact, uniform
Green Defender	87	1.5	12875	90	1.7	15488	vlg, lumpy, leafy, excess stalk
Kayak	100	0.6	5909	87	0.5	4292	med-lg, exerted, late br. bead
Laser	100	0.7	7240	100	0.6	6070	med-lg, lumpy
Neptune	100	1.2	11959	100	0.9	8591	lg, somewhat lumpy, leafy
Oktal	90	0.5	4013	93	0.4	3979	sm, very early, lumpy
Premium Crop*	93	1.3	11393	90	0.8	7038	lg, compact, some corky stem
Septal	93	0.5	4078	83	0.7	5945	sm, somewhat lumpy
Southern Comet	73	0.4	2831	93	0.3	3014	sm, very early, compact
Skiff	100	1.4	13108	87	1.3	11337	lg-vlg, lumpy, late br. bead
Symphony+*	97	0.8	5874	100	0.7	6958	lg, exerted, compact, uniform
Second Crop							
Dandy Early	90	1.3	10950	73	1.0	7187	lg, somewhat lumpy, variable
Early Emerald	93	1.0	9002	90	0.8	7179	lg, somewhat lumpy, variable
Galaxy*	100	1.0	9720	97	1.0	9187	lg, compact, uniform
Green Comet*	100	0.6	5990	93	0.6	5647	med-lg, compact, uniform
Packman*	100	1.1	10527	90	1.1	9418	lg-vlg, compact, uniform
Premium Crop*	83	0.9	7331	90	0.8	6574	med-lg, compact, uniform
Southern Comet*	90	0.9	7888	100	0.8	7684	med-lg, compact, uniform
Symphony+*	100	1.1	10870	97	1.0	9309	lg, exerted, compact, uniform

+Formerly XPH 5004

*Cultivars produced high quality heads at both Windsor and Mt. Carmel.

TABLE 6--YIELD AND QUALITY OF BROCCOLI AT WINDSOR AND MT. CARMEL, FALL 1987

	Windsor			Mt. Carmel			
Cultivar	Heads Hvst. %	Avg. Head lb	Total Yield lb/A	Heads Hvst. %	Avg. Head lb	Total Yield lb/A	Size and quality of heads
Corvet	100	1.1	10830	97	1.0	8944	med-lg, loose-compact, variable
Cruiser*	97	1.4	13457	93	0.8	7114	med-vlg, compact, uniform
Dandy Early	93	1.5	13303	97	1.1	9915	lg-vlg, yellowing, br. bead, variable
Emperor*	100	1.2	11314	100	0.9	8813	med-lg, compact, uniform (MC), rot (W)
Galaxy	100	1.0	10063	97	0.8	7832	med-lg, lumpy, leafy, br. bead, rot (MC)
Green Belt*	100	0.7	7058	100	0.9	8853	med-lg, compact, uniform
Green Defender	97	0.7	6880	100	0.9	9136	med-lg, compact, early heads leafy
Green Valiant*	93	0.8	7154	100	1.0	10063	med-lg, compact, uniform, late br. bead (W)
Kayak	97	0.4	3703	100	0.5	4429	sm-med, compact, exerted
Laser	93	1.2	10891	97	0.7	6455	med-lg, loose-compact, excess stalk
Neptune	90	1.2	10084	100	0.8	7684	med-lg, very lumpy, rot (W)
Oktal	100	1.2	11576	100	0.9	8510	med-lg, somewhat lumpy, rot (W)
Packman*	97	1.1	10543	100	0.7	6998	med-lg, compact, uniform (W), rot (MC)
Pirate	97	0.8	7629	100	1.1	10487	med-lg, lumpy, br. bead, rot (W)
PSR 21284	97	0.7	6962	100	0.7	6393	med-lg, somewhat lumpy, rot (MC)
PSR 35184	97	0.9	8762	97	0.7	6658	med-lg, severe br. bead
Septal	87	1.3	10992	100	0.9	8672	med-lg, somewhat lumpy, minor rot (MC, W)
Skiff	97	1.2	10908	100	0.8	7744	med-vlg, somewhat lumpy, br. bead, variable
Southern Comet	100	0.7	6413	-	-	-	sm-med, compact, uniform
Symphony+*	100	0.9	8974	97	0.7	6394	med-lg, compact, uniform
Second Crop							
Cruiser*	100	0.6	5364	97	0.6	5828	sm-med, compact, uniform
Emperor*	100	0.7	6312	100	0.7	6857	sm-med, compact, uniform
Galaxy	100	0.7	7038	90	0.8	6675	med, leafy
Green Belt*	100	0.7	6897	97	0.8	7851	med, compact, uniform
Green Valiant*	100	0.8	7381	97	0.9	8236	med-lg, compact, uniform
Packman*	100	0.8	7582	100	0.8	7623	med, compact, uniform, late heads leafy
Symphony+*	100	0.6	6151	100	0.8	7704	med-lg, compact, uniform
Third Crop							
Cruiser	90	0.7	6151	87	0.5	4231	med-lg, compact, uniform
Emperor*	100	0.8	7784	90	0.7	5929	med-lg, compact, uniform
Galaxy	97	0.6	5585	93	0.5	4139	sm-med, leafy
Green Belt*	100	0.7	6695	93	0.6	5807	med-lg, compact, uniform
Green Valiant*	93	0.9	8259	97	0.8	7407	med-lg, compact, uniform
Packman	93	0.7	6551	97	0.5	5060	sm-med, somewhat leafy
Symphony+	93	0.5	4602	90	0.4	3550	sm, compact, uniform, late heads leafy

+Formerly XPH 5004

*Cultivars produced high quality heads at both Windsor and Mt. Carmel.

Connecticut Valley may improve the yields of these early maturing cultivars, similar to Packman.

Fall crop. Most cultivars planted in spring were repeated in fall. Second and third crops were planted at 2-week intervals following the first planting. As in spring, I chose cultivars of known high quality to evaluate their usefulness in serial plantings to prolong fall harvests.

The average yield of all cultivars at Windsor was 9375 lb/A compared to 7952 lb/A at Mt. Carmel, a difference of 18%. Compared to spring yields, the fall yields were 18% higher at Windsor and 5% higher at Mt. Carmel.

At Windsor 13 of 20 cultivars yielded above the national average of 4 tons/A while 9 of 20 exceeded the national average at Mt. Carmel. At Windsor, Cruiser and Dandy Early yielded over 6.5 tons/A. Cruiser, Emperor, Green Valiant, Packman, and Symphony had high yields and excellent quality. The quality of Green Belt was excellent but yields were somewhat lower than the national average. The quality of Dandy Early was poor with rank, uneven growth on most heads.

At Mt. Carmel, Pirate and Green Valiant yielded 5 tons/A. Green Valiant had high quality heads but Pirate's heads were borne on excessively thick stalks. Of the other cultivars yielding above the national average, Emperor and Green Belt also had high quality heads. Packman and Symphony had lower than average yields but quality was generally good.

In mid-September, heavy rains and prolonged cloudy weather caused a widespread outbreak of bacterial soft rot. Cultivars nearing maturity were affected. Emperor, Neptune, Pirate, and Septal were affected in Windsor while Galaxy, Packman and Septal were mostly affected at Mt. Carmel. Galaxy and Packman were unaffected at Windsor because their heads had already been harvested.

The average yields of all cultivars grown in the second crop were 6675 lb/A at Windsor and 7253 lb/A at Mt. Carmel. Only Green Valiant exceeded the national average yield at Mt. Carmel and Green Belt was just slightly. below average in yield. Despite modest yields of all cultivars, quality was excellent except Galaxy with leafy heads.

The average yields of all cultivars in the third crop was 6518 lb/A at Windsor and 5190 lb/A at Mt. Carmel. The data show that average yields decrease progressively from the first to the third crops. This is in response to decreasing temperatures and shorter day length. Despite less favorable conditions, Green Valiant and Emperor retained high yields at both sites. The data suggest that these two cultivars are best for transplanting in mid-August for early November harvest in the Connecticut Valley. Although yields of Green Belt were somewhat low, quality remained good. The heads of Cruiser, Galaxy, Packman, and Symphony were small to medium and somewhat leafy. The small heads, however, can be bunched for market.

Maturity. In Table 7, the days to maturity were calculated from the day of transplanting to the day when half the heads were harvested.

For the spring crop, time to maturity among the 15 cultivars varied from 40 to 67 days at Windsor and 37 to 69 days at Mt. Carmel. The average maturity of all cultivars was 52 days at Windsor and 49 days at Mt. Carmel, a difference of only 3 days. In comparing maturities between the first and second crops, only Galaxy, Green Comet, Premium Crop, Southern Comet, and Symphony were common to both plantings. At Windsor these five cultivars had an average maturity of 49 days in the first crop and 46 days in the second crop. At Mt. Carmel the average maturity of the five cultivars was 45 days in the first crop and 43 days in the second crop. Although these differences are not large, they represent a trend to decreasing maturity of cultivars as plants mature with increasing temperature in late June and early July. These data suggest that planting a second crop 2 weeks after the first one will result in a harvest a few days less than 2 weeks.

In fall, the average maturity of all cultivars in the first crop was 59 days at Windsor and 66 days at Mt. Carmel. Thus, broccoli as well as cauliflower took longer to mature at Mt. Carmel. Cruiser, Emperor,

TABLE 7--MATURITY OF BROCCOLI AT WINDSOR AND MT. CARMEL, SPRING AND FALL 1987.

	Windsor				Mt. Carmel			
	Harvest Midpoint		Harvest Span		Harvest Midpoint		Harvest Span	
Cultivar	Spring Days*	Fall Days*	Spring Days**	Fall Days**	Spring Days*	Fall Days*	Spring Days**	Fall Days**
Corvet	57	71	13	11	55	77	10	13
Cruiser	53	55	16	3	55	59	10	11
Dandy Early	-	55	-	6	-	59	-	10
Embassy	57	-	10	-	55	-	3	-
Emperor	-	61	-	3	-	63	-	11
Galaxy	43	47	7	8	37	56	20	3
Green Belt	-	64	-	7	-	73	-	7
Green Comet	53	-	10	-	55	-	3	-
Green Defender	67	68	7	4	69	73	7	7
Green Valiant	-	64	-	4	-	70	-	3
Kayak	60	61	17	1	58	70	14	10
Laser	47	55	10	10	45	63	10	7
Neptune	53	61	13	1	48	70	13	7
Oktal	40	55	7	7	37	63	7	7
Packman	-	51	-	8	-	56	-	3
Pirate	-	68	-	7	-	77	-	14
Premium Crop	60	-	6	-	55	-	7	-
PSR 21284	-	55	-	3	-	63	-	4
PSR 35184	-	61	-	10	-	67	-	7
Septal	43	55	13	3	35	63	13	10
Skiff	63	64	10	10	58	73	17	17
Southern Comet	40	54	3	4	35	-	10	-
Symphony+	47	51	3	8	42	56	13	3
Second Crop								
Cruiser	-	55	-	10	-	59	-	11
Dandy Early	45	-	7	-	39	-	10	-
Early Emerald	40	-	13	-	39	-	10	-
Emperor	-	59	-	11	-	62	-	10
Galaxy	48	52	13	7	39	52	13	7
Green Belt	-	74	-	21	-	76	-	28
Green Valiant	-	66	-	7	-	66	-	14
Packman	47	52	13	11	43	55	7	7
Premium Crop	48	-	10	-	49	-	10	-
Southern Comet	41	-	13	-	39	-	13	-
Symphony+	45	52	7	3	43	55	10	4
Third Crop								
Cruiser	-	63	-	13	-	70	-	13
Emperor	-	70	-	7	-	77	-	10
Galaxy	-	57	-	11	-	59	-	11
Green Belt	-	80	-	8	-	87	-	7
Green Valiant	-	80	-	3	-	80	-	10
Packman	-	57	-	5	-	59	-	4
Symphony+	-	57	-	6	-	59	-	4

+Formerly XPH 5004
*Time from transplanting to midpoint of harvest.
**Time from start to finish of harvest of primary heads.

Galaxy, Green Belt, Green Valiant, Packman, and Symphony were used to compare maturities among three plantings. At Windsor the average maturity of the seven cultivars increased from 56 days to 59 days to 66 days for successive plantings. At Mt. Carmel the average maturity of the seven cultivars was 62 days for the first two plantings and 70 days for the third. The data show that maturity increases 6 to 10 days for late plantings in mid-August. This is highly important in areas where early frosts damage crops in the normally colder areas of Connecticut. The increased days to maturity may preclude late plantings in Litchfield and Windham Counties.

The span of harvest in spring ranged from 3 to 17 days at Windsor and 3 to 20 days at Mt. Carmel, and was fairly consistent at both sites. Symphony, known for its short harvest span, took almost 13 days at Mt. Carmel compared to 3 days at Windsor, while Galaxy took 20 days to harvest at Mt. Carmel compared to 7 days at Windsor. These long harvest spans however, are beneficial to growers of broccoli for roadside markets.

In fall, several cultivars had short harvest spans of less than a week at both sites and a few had spans exceeding 14 days. At Windsor the average harvest span of all cultivars was 6 days and at Mt. Carmel, 8 days.

PLANTING STRATEGIES

An objective in growing cauliflower and broccoli for commercial markets is to select several cultivars with varying days to maturity or planting two or more crops of one variety in succession to ensure continuous production throughout the desired period. The following strategies based on our trials at Windsor and Mt. Carmel are offered to assist growers in cultivar selection and planting times.

The 1987 trials demonstrate that a spring crop of cauliflower and broccoli can be produced in Connecticut during June. A fall crop of each can be harvested from early September through mid-November except in the normally colder areas of Litchfield and Windham Counties where killing frosts occur late in October. The fall harvest is terminated by a killing frost with temperatures in the low 20s. Night temperatures between 25-32F have little detrimental effect on quality. Although maturity is slowed by the onset of cold weather, the flavor of broccoli may improve after mild frosts.

Cauliflower.

The spring harvest of cauliflower is shorter than the fall (Table 7). Production in June was accomplished with transplants set between April 21 to 27. Planting cultivars with varying maturity provided harvest from early June to mid-July. Inclusive dates for harvest of preferred cultivars are shown in Figure 1.

At Windsor, a combination of Polar Express and Andes provided the broadest harvest from June 6 to July 7. At Mt. Carmel, these two cultivars provided the broadest harvest span from June 13 to July 15.

A second planting of Polar Express at Windsor extended its harvest to July 13 but the second planting at Mt. Carmel fell within the harvest span of the first crop. A second

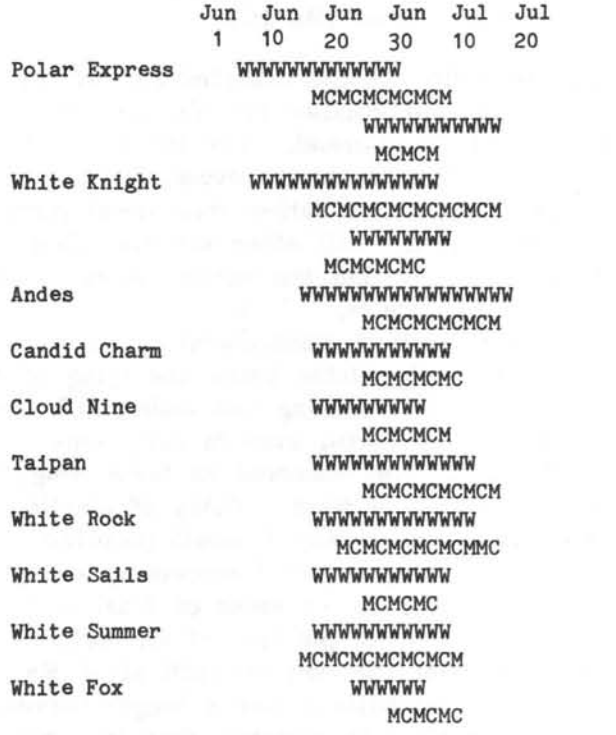

Fig. 1—Harvest dates for high quality cauliflower in the fall at Windsor (WWW) and Mt. Carmel (MCMC).

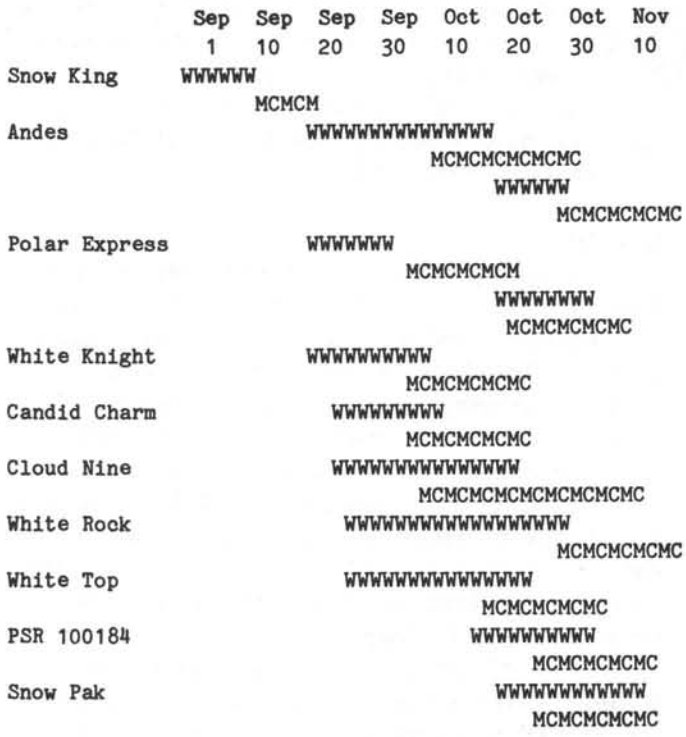

Fig. 2—Harvest dates for high quality cauliflower in the fall at Windsor (WWW) and Mt. Carmel (MCMC).

crop of White Knight extended its harvest span only 3 days at Windsor but did not extend the harvest at Mt. Carmel. For the spring crop, it seems easier to plant several cultivars of differing maturities rather than serial plantings of one cultivar. All other varieties listed in Figure 1 fell within the harvest spans of Polar Express plus Andes.

Two important management procedures, soil treatment with soluble boron and tying of all curds, ensured blanching and maintained the quality of the curds, even in early July.

Buttoning was observed on Snow King, an early maturing cultivar. Delay of planting of this cultivar until May 1 would probably reduce buttoning in the Connecticut Valley region. In the colder areas of Litchfield and Windham Counties, planting of all cultivars should probably be delayed until after May 1.

In fall, cauliflower had a longer harvest period and time to maturity than in spring. The combination of Snow King, Andes, and Snow Pak provided the broadest harvest span at Windsor from August 31 to November 13 (Figure 2). A second crop of Andes extended its harvest from October 19 to October 29. A second crop of Polar Express extended its harvest until November 2 but left an 18-day gap without harvest. The broadest harvest span, September 10 to November 13, was obtained at Mt. Carmel using Snow King as the early variety, either White Knight or Candid Charm as a middle variety, and White Rock as the late variety. A broad gap occurred, however, between September 18 and October 2. A second crop of Snow King planted one week after the first planting may have filled this gap. Unfortunately, the harvest span of Snow King is short and its maturity is more difficult to predict.

Quality of curds in fall production of cauliflower is also maintained by soil application of soluble boron to prevent hollow stem and browning of curds.

The first four cultivars of cauliflower listed in Figure 2 require tying to ensure blanching of curds. The last six are self-blanching. However, I observed that the self-blanching types that matured before mid-October could benefit by tying because curd growth out-paces the development of wrapper leaves. White Rock, White Top, Snow Pak, and PSR 100184 did not require tying at Mt. Carmel because they matured mid-to-late October.

Broccoli.

The harvest was shorter in spring than fall because of the onset of hot weather in July, which causes rank growth and yellowing of maturing heads. Harvest in June was from a first transplanting from April 21 to 28 and a second transplanting of early maturing cultivars from May 5 to 7. The harvest dates of preferred cultivars at Windsor and Mt. Carmel are shown in Figure 3.

At Windsor, three cultivars with different maturities provided harvest from June 9 to June 25. Cruiser and Symphony as a first crop and Southern Comet planted May 5 provided harvest from June 9 to June 25. Green Comet planted April 21 to 28 and Galaxy and Packman planted May 5 provided harvest from June 12 to 25. Premium Crop, a late maturing variety, extended the harvest

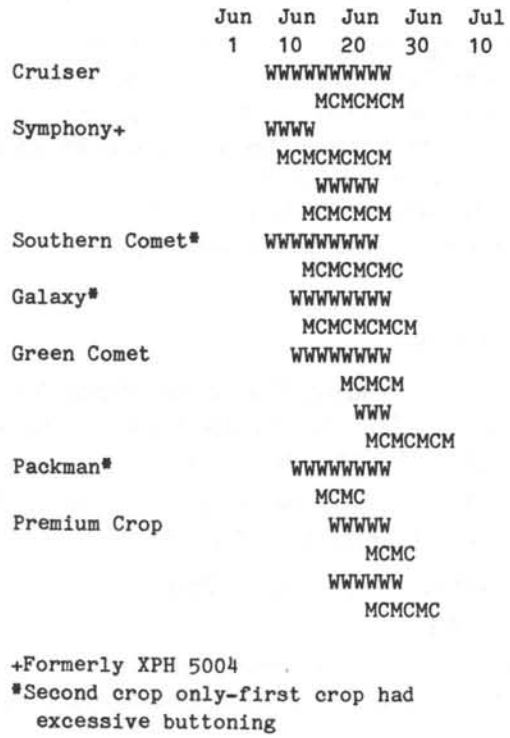

Fig. 3—Harvest dates for high quality broccoli in spring at Windsor (WWW) and Mt. Carmel (MCMC)

to June 29. At Mt. Carmel, the broadest harvest was accomplished with Symphony in the first planting and concluded with Green Comet in the second planting. Although both of these cultivars provided continuous harvest, intermittent harvests could be accomplished with Packman and Galaxy transplanted May 5. Since Symphony matures early and has a short harvest span, it may be possible to plant three successive crops 2 weeks apart beginning April 21 to 28 and extend harvest to late in June. It seems however, that use of cultivars with broader harvest spans such as Cruiser, Galaxy, Green Comet, and Packman may save planting time. To avoid buttoning, it is important to delay planting of early maturing varieties such as Southern Comet, Galaxy and Packman to early May.

The fall crop has a longer harvest period and permits more options for selection of cultivars and number of plantings. In addition to the 20 cultivars tested for the first fall crop, I tested second and third plantings of Cruiser, Emperor, Green Belt, Green Valiant, Packman, and Symphony. All but Green Belt

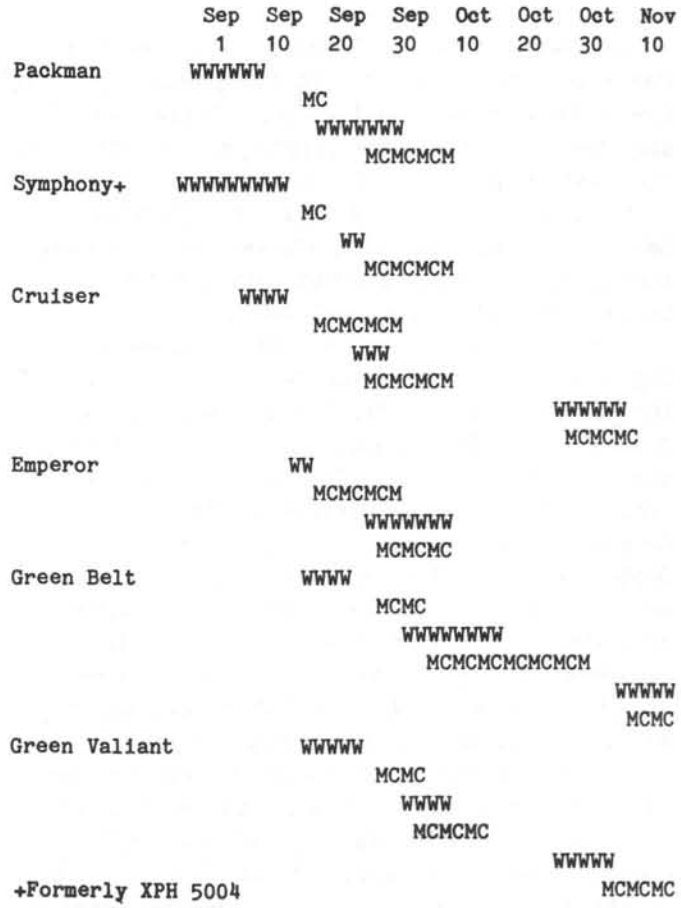

Fig. 4—Harvest dates for high quality broccoli in the fall at Windsor (WWW) and Mt. Carmel (MCMC)

and Cruiser, which are newly tested cultivars, had been suggested for the 1986 Broccoli Project. The harvest dates for the cultivars that produced consistently high quality heads in each crop are shown in Figure 4.

At Windsor, harvest of the first planting (July 15 to 22) began with Packman and Symphony on August 31 and concluded with Green Valiant on September 24. These cultivars provided continuous production except for a 6-day span. The harvest of the second planting (August 1) began with Packman on September 17 and concluded with Green Belt on October 19. All cultivars produced high quality heads in the first and second crops. Harvest of the third crop, planted August 17 to 18, began with Cruiser on October 26 and concluded with Green Belt on November 13. Green Valiant also produced high quality heads

at the same time as Cruiser. The heads of Packman, Emperor, and Symphony were inconsistent in size and leafy. Galaxy was also tested in all three plantings. At Windsor, the first crop had a 40% loss due to bacterial soft rot and the second and third plantings had leafy heads on thick stalks. In the 1987 trials, Galaxy did not match its excellent performance of spring and fall 1986.

At Mt. Carmel, harvest of most cultivars began 7 to 16 days after Windsor. Harvest of the second crop at Mt. Carmel began only 2 to 6 days after Windsor and the third crop was delayed only 2 to 5 days. In the second crop at Mt. Carmel, harvest of Packman, Cruiser, Green Valiant, and Symphony began on September 25 and concluded with Green Belt on November 3. In the third crop continuous harvest was provided from October 27 to November 12 by Cruiser and Green Valiant.

Figure 4 shows that mid-July planting of Packman, Cruiser, or Symphony followed by an August 1 planting of Emperor, Green Belt or Green Valiant, and an August 15 planting of Green Belt, Green Valiant or Cruiser will provide continuous harvest from September 1 to about November 15. In the colder areas of Litchfield and Windham Counties, second plantings may be in jeopardy from early killing frosts so third plantings in mid-August would be very risky.

For a fall crop of broccoli, then, selection of cultivars with variable maturities coupled with second or third plantings can provide a balanced harvest from early September through early November in the Connecticut Valley and possibly to late in October in the normally colder areas of Litchfield and Windham Counties.

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ACKNOWLEDGMENT

I thank Abigail A. Maynard for faithful, capable assistance in the field, in evaluation of cultivars, and in compilation of data.

The Connecticut Agricultural Experiment Station, founded in 1875, is the first experiment station in America. It is chartered by the General Assembly to make scientific inquiries and experiments regarding plants and their pests, insects, soil and water, and to perform analyses for State agencies. The laboratories of the Station are in New Haven and Windsor; its Lockwood Farm is in Hamden. Single copies of bulletins are available free upon request to Publications; Box 1106; New Haven, Connecticut 06504. ISSN 0097-0905