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Annual Culture of Globe Artichokes Mulching and Planting Date Trials 1989-1992

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SUMMARY

During 1989-1990, experiments were conducted at Windsor (inland, sandy terrace soil) and Mt. Carmel (coastal, loamy upland soil) to evaluate the use of various mulches to maintain cool soil temperatures that are vital to the production of globe artichokes grown as annuals. Mulches of hay, undecomposed leaves, and undecomposed leaves underlain by black film maintained soil temperatures below 80F from planting to bud initiation. In bare control plots, soil temperatures on sunny days consistently reached 84-102F and devernalized some plants, rendering them barren. All mulches increased buds/plant and bud weight compared to unmulched controls. These increases were significant in 1990 but not in 1989. There were no significant differences among the mulches; however, undecomposed leaves over black film generally gave consistently higher yield than hay or undecomposed leaves alone. Fewer plants became barren due to devernalization in all mulch plots compared to unmulched controls.

During 1991-1992, experiments were conducted at Mt. Carmel to adjust the management schedule to eliminate the need for greenhouse space in the early growth of vernalized artichoke seedlings. Vernalized seedlings, grown in a greenhouse and transplanted to the field in early May, produced 90% of their buds from early July to mid August. Vernalized seedlings, grown in a cold frame and transplanted in the field in early June, produced 90% of their buds from mid July through September. A second crop of buds from sprouts growing from the root crown were harvested from 5-7% of the plants in 1991 and 13-18% of the plants in 1992. Average yield of artichoke buds ranged from 9,780 buds/A in 1991 to 26,680 buds/A in 1992. The production schedule for both early and late crops allows harvests at a time when California production is low and provides opportunities for Connecticut growers for sales at roadside stands or farmers markets.

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The perennial culture of globe artichokes requires a Mediterranean-like climate with cool summers and mild winters. Under these conditions, artichokes grow from rootstocks that continuously produce shoots for 4 or 5 years (Ryder, DeVos, and Bari 1983). When grown from seed, however, the artichoke plant is biennial, growing vegetatively the first year and producing edible flower buds the second year. This two-year cycle requires milder winters than occur in Connecticut. The growth cycle can be shortened to 5-6 months by vernalization (moist chilling) of seed and application of gibberellic acid (GA_3) to young plants (Gerakis, Markarian, and Honma 1969). I first demonstrated that these techniques enable satisfactory production of buds in Connecticut on plants grown as annuals (Hill 1987).

We are interested in artichokes as an alternative crop in Connecticut because 40% of California's crop is shipped to regional markets in New York and Boston (Anon 1985). In earlier studies, we determined that application of hay mulch following planting conserved moisture, maintained cool soil temperatures, and improved yields (Hill and Maynard 1989). Unfortunately, the hay, adulterated with weed seeds, produced weeds which had to be controlled by hand. In addition, many growers, interested in producing artichokes for local roadside sales or farmers markets, lacked greenhouse space required for early growth of seedlings in the original production schedule.

In this bulletin, I shall evaluate the use of undecomposed leaves as an alternative mulch in the production of artichoke buds. I will also present a late production schedule that eliminates the need for greenhouse space. The early and late production schedules will be evaluated for yield, bud weight, maturity, and harvest duration.

METHODS AND MATERIALS

Mulch trials

Vernalization was initiated February 1 after soaking the seeds in tap water for 2 days at room temperature. Seeds that remained floating on the surface were discarded because their germination was very low. Seeds of 'Green Globe' were packed in moist, unshredded sphagnum moss in an unsealed plastic bag and refrigerated for 4 weeks at 36-40F. The seeds were examined weekly and moistened, if necessary. Four-week-old germinated seeds were planted in 1-quart containers filled with Promix BX and placed closely packed in a greenhouse maintained at 50-75F to prevent devernalization (Harwood and Markarian 1968). If greenhouse temperatures exceeded 80F during the day, plants were sprayed with cold water early in the afternoon. Perimeter containers, fully exposed to sunlight, were draped with aluminum foil to prevent excessive heat absorption through the side of the container. About 20% extra seedlings were grown to allow culling of stunted plants before planting in the field. Seedlings in the 4-leaf stage were transferred to a cold frame in early April. Seedlings were covered at night only on the threat of frost. Seedlings were transplanted in the field May 1.

Mulch trials were conducted in 1989-1990 at the Valley Laboratory, Windsor on Merrimac fine sandy loam, a sandy terrace soil with somewhat low moisture holding capacity and at Lockwood Farm, Mt. Carmel on Cheshire fine sandy loam, a loamy upland soil with moderate moisture holding capacity. The soils were fertilized at the rate of 1300 lb/A 10-10-10 (130 lb/A N, 56 lb/A P, 108 lb/A K). Soil pH was 6.5 at both sites. In 1990, soil temperatures were taken periodically with a dial thermometer at a 3-inch depth midway between rows at noon to 2 PM. In the mulch experiment, 15X8-foot plots were established in a random block design with four replications. Mulch treatments included 4 inches hay, 4 inches undecomposed leaves (mostly oak and maple), and 4 inches undecomposed leaves underlain by 4 mil black film to avoid possible phytotoxic effects of phenolic compounds leached from decomposing leaves (Hill et al. 1982).

The container-grown plants had prominent taproots curled at the bottom of each container. After the rootball was removed from the container, the taproot was straightened, and the plant was set in a hole deep enough to accommodate its length. About May 1, plants were set 2 feet apart within

Table 1. Conventional and alternative schedule for globe artichoke production. Dates are approximate

		Conventional (Early Crop)	Alternative (Late Crop)
Vernalization		February 1	March 1
Greenhouse		March 1	--
Cold frame		April 1	April 1
Field planting	1991	May 2	May 30
	1992	May 20	May 29
Gibberellic acid treatment (as necessary)		July 10	July 20

rows 4 feet apart. Each plot contained 12 plants, a density of 5445 plants/A. All mulches were applied immediately after planting.

In mid-July, when the plants were at the 10-leaf stage, 100 ppm GA_3 was sprayed on the center foliage of only those plants that showed no flower buds. Spraying plants with undetected buds resulted in rapid elongation of a thin stem too weak to support the growing bud.

Artichokes were harvested and weighed before the lowest bracts on the bud began to unfurl. Artichokes weighing less than 2.5 oz were discarded. These discards were generally smaller than the 60 size class (60 buds per standard box), the smallest commercial grade. Weeds on unmulched controls were removed by cultivation. Weeds on mulched plots were removed by hand.

Alternative date trials

In the alternative date trials, all procedures were similar to those outlined in the mulch trials with respect to vernalization of seeds, handling of seedlings, fertilization, and planting. To eliminate the need for greenhouse space in the early stage of seedling development, an alternative schedule of dates was developed for vernalization, handling of seedlings, and field planting. The approximate dates of the alternative planting schedule (late planting) compared to the conventional schedule (early planting) are shown in Table 1.

Alternative planting date trials were conducted only at Mt. Carmel on Cheshire fine sandy loam. Spacing of transplants was 2X4 feet, but plantings consisted of paired rows, each containing 27 plants in 1991 and 31 plants in 1992. All rows were mulched with 4 inches of undecomposed leaves immediately after transplanting. GA_3 treatment of barren plants in the late planting averaged 10 days later than the early planting. All weeds were pulled by hand.

RESULTS-MULCH TRIALS

Effect of mulch on soil temperature

All mulch treatments maintained cool soil temperatures. Between transplanting and bud formation, soil temperatures at a 3-inch depth on plots mulched with hay, undecomposed leaves, and undecomposed leaves underlain by black film were maintained below 80F. On sunny days, temperature in the bare soil of the control plots reached 85-102F. The higher temperatures in the unmulched plots were observed on days when the soil moisture content was well below field capacity, especially in the sandy soil at Windsor.

Barren plants and their response to gibberellic acid

The percentages of plants in each treatment that required GA_3 treatment in mid-July at both sites in 1989 and 1990 are shown in Table 2. At Windsor, 36% and 14% of the entire crop required GA_3 treatment in 1989 and 1990, respectively, compared to 11% and 6% at Mt. Carmel. The greater delay in the initiation of buds at Windsor may be due to lower moisture content in the sandy soil that allowed daily soil temperatures to rise quickly into the 85-102F range. At Mt. Carmel, the higher moisture holding capacity of the loamy soil slowed the daily rise in temperature so that high temperatures were attained for only short periods in the afternoon. After treatment with GA_3, most barren plants formed buds within 3 or 4 weeks on all mulched plots. A greater percentage of plants did not respond to GA_3 treatment on bare soil. It is obvious that these plants were devernalized in the field due to excessively high soil temperatures. Thus, mulch maintained vernalization in the plants by providing cool soil temperatures and allowed the greatest number of plants to produce buds.

Yield and bud weight

The dominant feature of all mulched plants was the general increase in buds/plant compared to unmulched controls (Table 3). In 1989, these increases at both sites were not significant except on plots mulched with undecomposed leaves over black film at Windsor. In 1990, at Windsor and Mt. Carmel, all mulch treatments significantly increased buds/plant compared to unmulched controls. At both sites in 1989 and 1990, there were no significant differences among the various mulch treatments. The greatest number of buds/plant among all treatments occurred on plots mulched with undecomposed leaves over black film at both sites in 1989 and undecomposed leaves alone at both sites in 1990.

Total buds/acre, adjusted for barren plants, was greater on all mulch treatments compared to unmulched controls. The lower production on unmulched controls at Windsor in 1989 and 1990 and at Mt. Carmel in 1990 was due not only to fewer buds/plant but also 12-17% barren plants. Bud production in 1989 at Mt. Carmel for all mulched plots exceeded 18,500 buds/acre and was the highest in 5 years of trials (Hill 1987; Hill and Maynard 1989).

The effect of mulch on bud weight was somewhat similar to the effects on buds/plant (Table 3). In 1989 at Windsor, average bud weight of plants mulched with hay or undecomposed leaves over black film was significantly greater than bud weight of unmulched plants.

Table 2. Treatment of barren plants of 'Green Globe' artichoke with gibberellic acid (100 ppm) in mulched plots at Windsor and Mt. Carmel July 14, 1989-1990.

	Windsor			Mt. Carmel		
	No. Barren Plants	% of Total*	No. plants Failing to Respond	No. Barren Plants	% of Total*	No. plants Failing to Respond
MULCH TREATMENT 1989						
Undecomposed leaves over black film	16	33	2	1	2	0
Undecomposed leaves	18	38	9	4	8	0
Hay	24	50	0	11	23	0
Bare control	11	23	8	5	10	0
MULCH TREATMENT 1990						
Undecomposed leaves over black film	5	10	1	2	4	0
Undecomposed leaves	3	6	1	0	0	0
Hay	5	10	1	1	2	0
Bare control	13	27	8	8	17	6

* 12 plants/treatment x 4 replications = 48 plants/treatment.

Table 3. Yield and weight of 'Green Globe' artichoke buds on mulched and unmulched plots at Windsor and Mt. Carmel 1989-1990.

	Windsor				Mt. Carmel			
	Plants w/buds %	Buds/ Plant No.	Buds/ Acre* No.	Bud wt. oz.	Plants w/buds %	Buds/ Plant No.	Buds/ Acre* No.	Bud wt. oz.
MULCH TREATMENT 1989								
Undecomposed leaves over black film	96	3.2a**	16,730	5.6a**	100	4.4a**	23,960	5.3a**
Undecomposed leaves	81	2.6ab	11,470	4.9ab	100	3.4a	18,510	4.9a
Hay	100	2.8ab	15,250	5.6a	100	4.0a	21,780	6.2b
Control	83	2.2b	9,940	4.6b	100	3.2a	17,420	5.6ab
MULCH TREATMENT 1990								
Undecomposed leaves over black film	98	2.8a	14,940	6.6a	100	2.3a	12,520	6.3a
Undecomposed leaves	98	2.9a	15,470	6.5a	100	2.6a	14,160	5.6ab
Hay	98	2.4a	12,810	7.0a	100	2.0a	10,890	5.8a
Control	83	1.6b	7,230	5.5b	88	1.6b	7,670	4.8b

* Based on 5445 plants/acre x buds/plant x % plants with buds.

** Mean separation within columns by Duncan's new multiple range test at P = 0.05. Values in columns followed by the same letter did not differ significantly.

In 1989 at Windsor, fully 50% of the plants mulched with hay were barren in early July and required GA_3 treatment compared to 23-38% in other treatments (Table 2). These plants eventually formed buds in August and September when the plants were larger. In 1989 at Mt. Carmel, bud weight on plants mulched with hay was significantly greater than on those mulched with undecomposed leaves over black film or undecomposed leaves alone (Table 3). In 1989 at Mt. Carmel, the greatest number of barren plants in July occurred on plots mulched with hay. All responded to GA_3 treatment and produced late buds on large plants.

In 1989, buds/plant and bud weight in plots mulched with undecomposed leaves at both sites were lowest among all mulched plots (Table 3). The same trend continued in 1990 for bud weight alone. Although the reduction in buds/plant and bud weight were not significant, it may indicate a slight phytotoxic response to undecomposed leaves. The possible phytotoxic effect of substances leaching from decomposing leaves is slight because taproots of artichoke plants are deep enough in the soil so that they are less affected than crops we have studied with shallow root systems (Hill et al. 1982).

In 1990 at Windsor, all mulched plants produced significantly heavier buds than unmulched controls. There were no significant differences among the various mulch treatments. At Mt. Carmel, plants mulched with undecomposed leaves over black film or hay produced significantly heavier buds than unmulched controls.

RESULTS
ALTERNATIVE PLANTING DATE TRIALS

Rainfall and temperature, 1991-1992 growing seasons

Rainfall distribution throughout the 1991 and 1992 growing seasons is shown in Figure 1. Each monthly bar represents the departure of monthly rainfall (inches) from normal reported by the National Weather Service for the weather station at Mt. Carmel. Total rainfall from April through October was 31.2 inches in 1991 and 29.4 inches in 1992 compared to a normal of 23.8 inches. Soil moisture reserves were adequate for crop needs from July through September in 1991 and June through September in 1992. Most of the large surplus in August 1991 and June 1992 was supplied by coastal storms yielding 5-6 inches of rain in a single day. Soil moisture reserves were inadequate between April and mid-July in 1991 and April through May in 1992. In May 1992, newly planted seedlings required irrigation.

Average temperature for the early part of the growing season is shown in Figure 2. In 1991, the average temperature from April through July was 2-7F above normal. On April 7-9, while the seedlings were in the cold frame, air temperatures rose to 85-87F. In June, when buds normally form, temperatures exceeded 85F on 15 of 30 days.

In 1992, at Mt. Carmel, average temperatures from April through July varied less than 1F from normal.

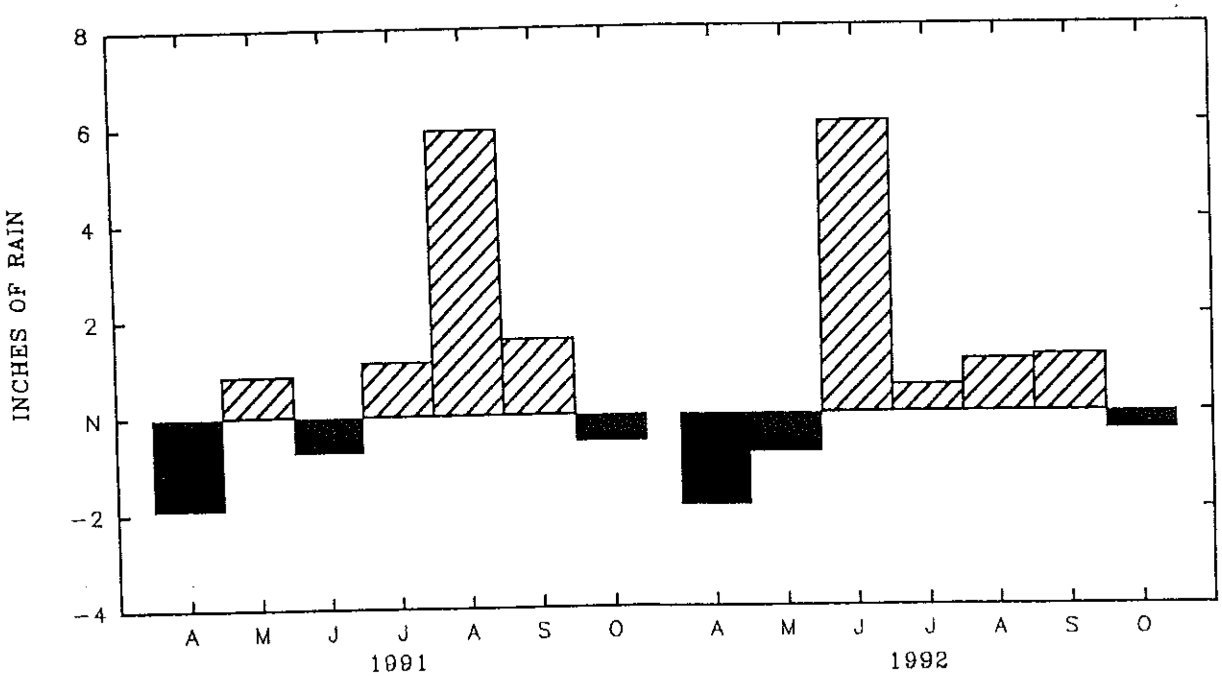

Figure 1. Precipitation departure (inches) from normal (N) at Mt. Carmel weather station during growing seasons 1991-1992.

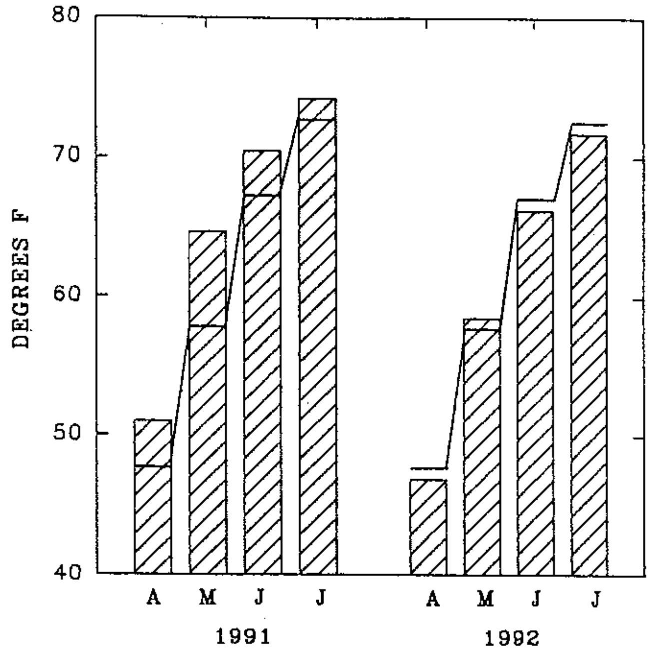

Figure 2. Average monthly temperature at Mt. Carmel weather station during growing seasons 1991-1992. The solid line represents the 25-year average monthly temperature.

Yield and bud weight-1991 crops

Temperature and rainfall profoundly affected artichoke yields and bud weight in both early and late crops in 1991. Dry weather and high temperatures in April and June not only increased the percentage of barren plants in both crops by devernalization but also stunted the plants in the early crop. The number of buds/plant in the early crop was about half those produced in the late crop (Table 4). Buds from the early crop were also smaller and weighed about 1 ounce less than those in the late crop. Fully 80% of the plants of the late crop had not formed buds by mid July compared to 26% in the early crop. After GA_3 treatment, 75% of the barren plants formed buds for late harvest. The yield in buds/acre of the early crop was lower than reported in past yield trials (Hill 1987, Hill and Maynard 1989), a clear reflection of unfavorable weather during early growth of the early crop. Weather conditions improved as the late crop matured, and average yields were produced.

Table 4. Yield and bud weight of 'Green Globe' artichokes at Mt. Carmel 1991-1992.

	1991		1992	
	Early	Late	Early	Late
% Plants Producing Buds	85	80	98	100
No. Buds/Plant	1.5	2.9	4.9	5.0
No. Buds/Acre*	6,940	12,630	26,150	27,220
Wt/Bud (oz)	4.8	5.8	6.6	5.8
% Plants with 2nd crop of buds	7	5	13	18

* Plants/Acre X Buds/Plant X % Producing

Yield and bud weight-1992 crops

In 1992, despite rainfall deficiencies in April and May, average temperatures for those months maintained vernalization in the plants. Only 10% of the early crop and 18% of the late crop required GA_3 treatment. Fully 98-100% of both crops eventually produced buds. Bud formation was prolific in both the early and late crops, 4.9 to 5.0 buds/plant (Table 4). Yields exceeded 26,000 buds/A in both crops, the highest yields reported in Connecticut. The favorable weather produced a high yield of large and heavy buds in the early crop. Virtually all primary and secondary buds were in the 24 size class. In the early crop, average bud weight was 38% heavier than in the early crop of 1991. In the late crop, bud weight was 13% less than the early crop, but similar to bud weight of the late crop in 1991.

Harvests from basal sprouts

Each plant died back after all of its buds were harvested. Soon new sprouts emerged from the root crown. The larger sprouts produced a second crop of buds in late October and early November. In 1991, 5-7% of both plantings produced buds; in 1992, 13-18% produced buds. Most of the buds produced on sprouts were in the 48 or 60 size classes. Although some of these buds were slightly bronzed by early frosts, their edible quality was not impaired.

Distribution of yield in early and late crops

Although total harvest of buds in both early and late crops in 1991 was below normal, the distribution of harvest followed a familiar pattern (Hill and Maynard 1989). Harvest of buds in the late crop began July 18 compared to June 27 for the early crop, a lag of 3 weeks (Figure 3). Fully 90% of the buds of the early crop were harvested by the 10th harvest week (August 21). In the late crop, most of the buds were harvested between the 6th (August 1) and the 15th (October 2) harvest weeks. The late crop was less affected by early drought and high temperature than the early crop.

In 1992, with near normal temperatures prevailing throughout the growing season, there was little difference in the distribution of harvest between early and late crops. However, the uniformity of distribution in both crops is, in part, due to a 2.5-week delay in planting the early crop. Harvest of buds in the late crop outpaced the harvest on the early crop up to the 6th harvest week. By the 13th week (October 1), 97% of the early crop and 93% of the late crop was harvested. Production continued until mid-November from buds formed on sprouts.

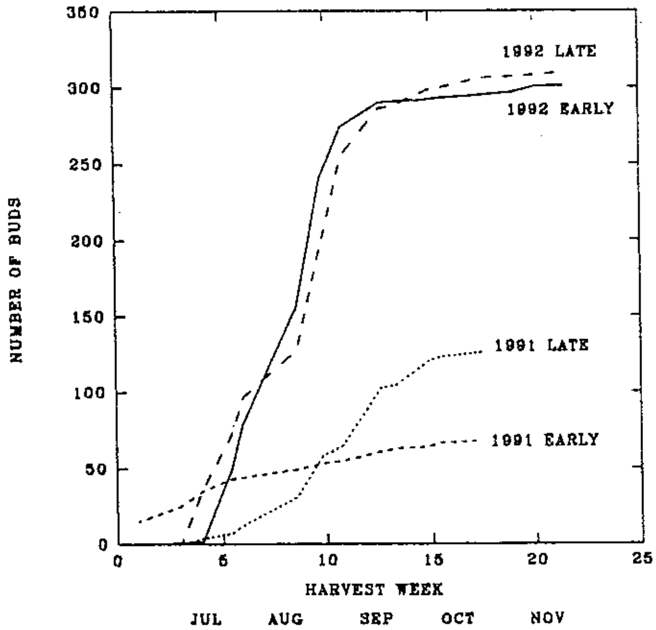

Figure 3. Cumulative yield of 'Green Globe' artichokes in early and late crops at Mt. Carmel 1991-1992.

MANAGEMENT STRATEGIES

Mulching

For optimum yields of artichoke buds, mulching of seedlings as soon as they are transplanted was essential. Four inches of mulch maintained vernalization and production from a large percentage of plants. Many unmulched plants devernalized when soil temperatures rose above 80-85F for a few days. Mulch type caused little difference in yield and bud weight. Hay mulch maintained vernalization, but introduced weed seeds. Undecomposed leaves, although more difficult to handle, were generally weed free. Although the combination mulch with undecomposed leaves over black film provided the greatest yields at both sites in 1991 and 1992 compared to unmulched controls, this combination would be the most costly in commercial production. It is doubtful whether the additional yield of buds would compensate the grower for the expense of the black film and its application in the field.

Alternative planting dates

The early planting schedule began with vernalization of seeds in February for harvest in late June or early July. This schedule has the advantage of early heavy production of buds from July to mid August then decreasing until October. Late production from an early crop is also possible if a large proportion of plants remain barren in mid July and are treated with GA_3.

There are several advantages of a late schedule with vernalization beginning in March. First, the need for greenhouse space is avoided, a saving in production costs. For growers without greenhouses, the later schedule permits harvest of artichoke buds beginning in August. This is still satisfactory because California production is meager as fields rest between crops. Second, for growers with greenhouse space, the production of an early and late crop provides maximum harvest from early July through September. During these months, direct marketing of artichoke buds through roadside stands and farmers' markets permits retail prices that are independent of California wholesale prices. Connecticut growers who have produced artichokes report that the advantages of freshness and taste appeal bring customers back for repeat sales.

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