The Connecticut Agricultural Experiment Station, New Haven

Globe Artichoke Trials—1987-1988

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Globe artichokes have been cultivated for hundreds of years in Mediterranean Countries. Early French and Spanish settlers in the southern and western United States introduced this thistle-like plant about 250 years ago. Its culture has been confined to areas with cool summers and mild winters that favor year-round supply. There, artichokes grow as perennials with root stocks continuously producing shoots for 4 to 5 years. Replanting is from divided roots or offshoots (Ryder, DeVos and Bari 1983).

When grown from seed, however, the artichoke is a biennial plant, growing vegetatively the first year and sending out edible flower buds the second year. This two-year cycle requires milder winters than occur in Connecticut. However, the growth cycle of the plant can be shortened by vernalization (moist chilling) of seed and application of gibberellic acid (GA3) to young plants (Gerakis, Markarian and Honma 1969). These treatments cause flower buds to form in 5- to 6-month-old plants; thus artichokes can be grown as annual plants.

We are interested in artichokes as an alternative crop because 40% of California's crop is shipped to regional markets in New York and Boston (Anon. 1988). Globe artichokes can be grown successfully in Connecticut, but our earlier experiments were confined to varieties that were available from domestic seed stocks (Hill 1987). It is important, however, to evaluate varieties common to the Mediterranean countries because their genetic variability is more diverse. For this Bulletin we determined the response to annual culture of 29 varieties from Italy, France, Greece, Israel, and the United States. We also determined the effect of close spacing on yield and weight of artichokes. Finally we determined the effect of mulch on production of buds.

MATERIALS AND METHODS

Vernalization

Vernalization was initiated between January 29 and February 3 for harvest of artichokes beginning in July. Seeds were soaked in water for 2 days at room temperature to soften the seed coat. They were then packed in moist unshredded sphagnum moss in an unsealed plastic bag and refrigerated for 4 weeks at 35-40 F. The seeds were examined weekly and moistened as necessary to prevent drying. Moist shredded peat moss does not allow adequate aeration and results in delayed germination or rotting of seeds.

Greenhouse Management

On March 2, four-week-old germinated seeds were planted in 1-quart plastic containers filled with Promix BX and placed in a greenhouse maintained at 50-75 F to prevent devernalization at higher temperatures (Harwood and Markarian 1968). In 1987, temperatures in the greenhouse rose to 90 F for several days in mid-April. About 20% extra seedlings were grown to allow culling of stunted plants before field planting. No supplementary light was used to extend day length.

Seedlings in the 4-leaf stage were transferred to a cold frame on April 24-30, 1987 to harden before transplanting in the field. In 1988, transfer of seedlings to the cold frame was completed by April 8. Cold frames were covered at night only on the threat of frost. Water soluble 20-20-20

fertilizer (one tbsp/gal) was added to the seedlings about 1 week before transplanting to the field.

Field Management

Trials were conducted 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 with 1300 lb/A of 10-10-10 and limed to attain a pH of 6.5. Plants were set in the field May 11-15, 1987 at both sites. In 1988, plants were set in the field April 27-May 3 at Windsor, and May 10-15 at Mt. Carmel.

The container-grown plants had prominent tap roots curled at the bottom of each pot. After the root ball was removed from the pot, the tap root was straightened, and the plant was set in a hole deep enough to accomodate its length. In all cultivar trials, plants were set 3 feet apart in rows 4 feet apart. Ten plants of each cultivar were planted in each of two replicates. In 1987, 29 cultivars from Italy (21), France (5), Greece (1), Israel (1), and the United States (1) were evaluated for their response to vernalization and GA3 treatment. In 1988, 11 of these cultivars were retested and mulched with 4 inches of straw.

In our experiments in 1984-1986 artichoke plants, grown as annuals, were spaced 3 x 4 feet (3630 plants/A) in comparison to a 6 x 8-foot spacing (1100 plants/A) in California where they are grown as perennials (Ryder, DeVos, and Bari 1983). Since we observed that the plants did not appear crowded even at the 3 x 4-foot spacing, we further reduced the spacing to 2 x 4 feet (5445 plants/A). In 1987 at Mt. Carmel we planted ten 60-foot rows of Green Globe (a domestic cultivar), alternating the rows with 2 and 3-foot spacings. All rows were 4 feet apart. Half of each row was mulched with 4 inches of straw to conserve moisture and maintain cooler soil temperature. The other half was untreated. In 1988 mulching trials at Windsor and Mt. Carmel, five rows of Green Globe were planted at a spacing of 2 x 4 feet. Again, half of each row was mulched with 4 inches of straw or hay.

On July 23-27 in both years, 100 parts per million GA3 was applied to the foliage of only those plants that showed no flower buds at the 10-leaf stage.

In 1987, pest control was not needed. In 1988, an infestation of aphids at Windsor was controlled with a single application of Pydrin. Weeds in unmulched portions of each row were controlled by cultivation.

Artichokes were harvested and weighed before the lowest bract on the bud began to unfurl. Artichokes smaller than 2.5 oz were culled.

RESULTS AND DISCUSSION

Cultivar Trials

Yields of the 29 cultivars tested in 1987 were poor (Table 1) compared to earlier trials with domestic cultivars (Hill, 1987). An average of only 13% of the plants in each cultivar grown at Windsor and 10% at Mt. Carmel produced buds. Average yields for each cultivar were 1696 buds/A at Windsor and 745 buds/A at Mt. Carmel. Grande Buerre and Green Globe Improved had the greatest percentage of plants producing buds at both sites, 40-60%. At Windsor, Grande Buerre had the greatest yield (6665 buds/A). Even though Baycompasa, Verde di Castellamare, Verde di Putignano and Violetto produced more than 4500 buds/A at Windsor, most weighed between 2.5 and 3 oz and were of poor quality with spiny bracts. Six cultivars produced no buds at either location.

The low percentage of plants producing buds was attributed to cultural problems with young plants. First, inadequate ventilation in the greenhouse and delay in moving the seedlings to the cold frame until late April caused the plants to be subjected to 90 F temperatures for several days. In all probability, these high temperatures devernalized the seedlings (Harwood and Markarian, 1968; Hill, 1987). It appears that Grande Buerre and Green Globe Improved were less sensitive to devernalization because a greater percentage of plants produced buds. Second, the plants were not

TABLE 1--YIELDS OF ARTICHOKE BUDS IN CULTIVAR TRIALS AT TWO SITES

Cultivar or District of Origin (Country)	1987 Windsor Plants W/buds %	1987 Windsor Buds/ Plant No.	1987 Windsor Buds/ Acre No.*	1987 Mt. Carmel Plants W/buds %	1987 Mt. Carmel Buds/ Plant No.	1987 Mt. Carmel Buds/ Acre No.*	1988 Windsor Plants W/buds %	1988 Windsor Buds/ Plant No.	1988 Windsor Buds/ Acre No.*	1988 Mt. Carmel Plants W/buds %	1988 Mt. Carmel Buds/ Plant No.	1988 Mt. Carmel Buds/ Acre No.*
Baycompasa (It)	20	6.3	4574	28	3.0	3049						
Blanc Hyerois (Fr)	0	0	0	0	0	0						
Camus De Bretagne (Fr)	5	2.0	363	0	0	0	70	2.2	5590	45	2.1	3430
Catanese (It)	11	3.0	1198	5	1.0	182						
Cuneo (It)	15	4.0	2178	15	1.7	926						
EB 5-EB9 (It)	0	0	0	13	2.0	944						
Grande Buerre (Fr)	68	2.7	6665	45	2.1	3430	95	1.6	5518	100	2.1	7623
Green Globe Imp. (US)	45	1.6	2614	40	2.2	3194	100	2.7	9801	95	1.7	5862
Green Globe - thornless (It)	15	4.0	2178	10	4.7	1706						
Mazzaferrata Di Termoli (It)	16	5.7	3310	0	0	0						
Mazzaferrata Di Toscana (It)	6	4.0	871	0	0	0						
Pasquaiolo (It)	0	0	0	5	1.0	182						
Portici (It)	19	2.3	2505	30	2.0	1379	95	1.9	6552	70	2.0	5082
Precoce Di Jesi (It)	0	0	0	0	0	0						
Romagna (It)	0	0	0	0	0	0	90	2.7	8821	35	2.3	2922
Romanesco (It)	0	0	0	0	0	0	90	2.1	6861	65	1.7	4011
Salanquet (Fr)	0	0	0	5	1.0	182						
Spinosa Di Palermo (It)	12	4.0	1742	30	1.7	1851						
Talpiot (Israel)	0	0	0	0	0	0	95	2.8	9656	90	2.1	6861
Unknown (Greece)	0	0	0	6	1.0	218	65	2.1	4955	25	2.4	2178
Unknown (Italy)	5	10.0	1815	15	1.0	544						
Verde Di Castellamare (It)	35	3.6	4574	20	1.5	1089						
Verde Di Pesaro (It)	31	2.5	2813	20	3.0	2178						
Verde Di Putignano (It)	35	4.4	5590	10	1.0	363						
Violet De Provence (Fr)	8	1.0	290	0	0	0						
Violetto (It)	17	9.0	5554	0	0	0						
Violetto Di Bologna (It)	5	1.0	182	5	1.0	182	85	3.1	9565	35	1.1	1398
Violetto Precoce (It)	0	0	0	0	0	0	70	2.6	6607	20	2.2	1597
Violetto Romanesco (It)	5	1.0	182	0	0	0	100	1.8	6534	65	1.2	2831
Average	13		1696	10		745	87		7314	59		3981

* Based on 3630 plants/A.

mulched, a practice which maintains cool soil and prevents devernalization.

In 1988, greenhouse temperature seldom exceeded 75 F. Seedlings were transferred to the cold frame 3 weeks earlier than in 1987 and were mulched after transplanting to the field. The yield increases were dramatic. Of 11 cultivars retested, an average of 87% of plants produced buds at Windsor and 59% at Mt. Carmel (Table 1). At Windsor, 7 of 11 cultivars had at least 90% of the plants producing buds; at Mt. Carmel 3 of 11. The average yield of all cultivars at Windsor was 7314 buds/A. The crop at Mt. Carmel averaged 3981 buds/A or 46% less. At Windsor, Green Globe Improved, Talpiot, and Violetto di Bologna yielded over 9,000 buds/acre. At Mt. Carmel, only Grande Buerre, and Talpiot produced over 6,500 buds/acre.

Lower bud production at Mt. Carmel, compared to Windsor, was due to a lower percentage of plants producing buds. Seedlings planted at Mt. Carmel may have been inadvertantly devernalized by exposure to higher temperatures in the cold frame. After the plants destined for Windsor were pulled from the cold frame 12 days earlier, the remaining seedlings in black plastic pots for Mt. Carmel were exposed to sunlight. Exposed black plastic becomes very hot as it absorbs the sun's radiation but transfers heat slowly to the soil in the pots (Waggoner, Miller, and DeRoo, 1960). Air temperatures at Mt. Carmel ranged between 70 and 75 F on 7 of 12 extra days that the seedlings for Mt. Carmel were in the cold frame. Soil temperatures in the exposed black pots on sunny days will be about 10 F higher than in shaded pots (Hill, unpublished data), well above devernalization temperatures (Gerakis, Markarian, and Honma, 1969).

Mulching and Plant Density

In 1987 the percentage of mulched Green Globe plants producing buds at the 2 x 4-foot spacing was about two-fold greater than plants on bare soil; at the 3 x 4-foot spacing, 64% more mulched plants produced buds (Table 2). Mulched plants also produced more buds/plant than unmulched plants. The effect of mulch

TABLE 2--YIELDS OF GREEN GLOBE ARTICHOKES IN SPACING AND MULCHING TRIALS AT MT. CARMEL--1987

Treatment	Spacing	Plants w/buds	Buds/ Plant	Buds/ Acre	Wt/Bud
	%	No.	No.*	oz.	
Mulch	2 x 4'	76	1.9	7768	4.4
Mulch	3 x 4'	72	1.6	4356	4.7
Bare	2 x 4'	35	1.1	2126	3.3
Bare	3 x 4'	44	1.3	2105	3.9

* 2 x 4' spacing = 5445 plants/A
3 x 4' spacing = 3630 plants/A

on both of these parameters accounts for the 3-fold and 2-fold increase in buds/A at the 2 x 4 foot and 3 x 4 foot spacings, respectively. Mulch not only conserves moisture, but also reduces soil temperature about 10 F (Hill, Hankin, and Stephens, 1982) and lessens the chance of devernalization in the field. Mulched plants also produced buds that were 20-33% heavier at both spacings than buds from unmulched plants. The average weight of buds at the narrower 2 x 4-foot spacing in mulched and unmulched plants was 6-16% less compared to the wider 3 x 4-foot spacing. This suggests greater competition among plants at the 2 x 4-foot spacing.

In 1988, the effect of mulch on yield and maturity of artichokes was tested at Windsor and Mt. Carmel but only at the 2 x 4-foot spacing. As noted earlier in the cultivar testing, production of buds was greater in 1988 than in 1987. In mulched plots, 100% of plants at Mt. Carmel produced artichokes; at Windsor 93% of Grande Buerre produced buds (Table 3). At both sites 88-98% of unmulched plants produced buds. As in 1987, mulched plants had more buds/plant than unmulched plants. In the mulched plots, Green Globe exceeded 10,000 buds/A at Windsor and Mt. Carmel, as did Grande Buerre at Mt. Carmel. This compares favorably with California yields of about 11,000 buds/A. The greater weight/bud from mulched plants compared to unmulched plants, observed in 1987, did not

occur in 1988. Only mulched Green Globe at Mt. Carmel produced slightly heavier buds. However, in June 1988 when the plants began to form buds, rainfall was the lowest on record. Virtually all water was supplied by irrigation and at times the plants may have been stressed.

The results indicate that mulching of transplanted artichoke seedlings prevented devernalization, reduced moisture stress during drought and promoted bud development. Its effect on bud weight was variable between seasons. We observed that mulched plants were larger and more vigorous.

Maturity

In 1987, harvest of artichokes of commercial quality began July 11-13 and concluded November 6-9 at both sites following 26 F temperatures. In 1988, harvest began on June 30 at Windsor and July 5 at Mt. Carmel, the earliest harvest dates since experiments began in 1984 (Hill, 1987). In 1988 the early harvest date at Windsor was attributed to planting in late April compared to planting in early May at Mt. Carmel. The harvest of Green Globe and Grande Buerre in the mulch trials concluded the week of September 23 at both sites but continued in the cultivar trials until October 10 at Windsor and October 31 at Mt. Carmel following temperatures in the mid-20's. Earlier frosts with temperatures 28-32 F did not damage the plants, but the buds suffered minor cracking and discoloration of the epidermis. Their overall quality and taste were not impaired.

The distribution of harvest throughout the growing season depends upon the success of vernalization and subsequent GA3 treatment. The harvest distribution in 1987 of mulched and unmulched Green Globe artichokes is shown in Figure 1. The harvest of buds in the first 4 weeks resulted from plants affected by vernalization alone. By early August, 55% of the mulched plants had produced a total of 105 buds. In comparison, only 23% of unmulched plants had produced a total of 29 buds. The effects of GA3 treatment of barren plants on July 23 (week 2) were first observed in harvest weeks 9 and 10 in early-September. Bud production in mulched and unmulched plants increased during harvest weeks 10-12 in mid-September. A second GA3 treatment of barren plants on August 19 again triggered bud production resulting in harvest increases in harvest weeks 15 and 16 in late October. By late-October 74% of mulched plants and 40% of unmulched plants had produced buds, an increase of 17-19% compared to early-August. This increase was due to GA3 treatments.

In 1988 at Windsor, over 90% of total Green Globe buds had been harvested in mulched and unmulched plots by the end of harvest week 5

TABLE 3--YIELDS OF GREEN GLOBE AND GRANDE BUERRE ARTICHOKES IN MULCH TRIALS AT TWO SITES--1988.

	Mulched				Unmulched			
Cultivar	Plants w/buds %	Buds/ Plant No.	Buds/ Acre No.*	Wt/ Bud oz.	Plants w/buds %	Buds/ Plant No.	Buds/ Acre No.*	Wt/ Bud oz.
				Windsor				
Green Globe	100	2.2	11924	3.9	98	1.6	8484	4.1
Grande Buerre	93	1.6	7890	3.5	93	1.3	6735	3.7
				Mt. Carmel				
Green Globe	100	1.9	10291	3.9	88	1.4	6804	3.4
Grande Buerre	100	2.1	11598	3.7	90	1.6	7988	3.9

* Based on 5445 plants/A

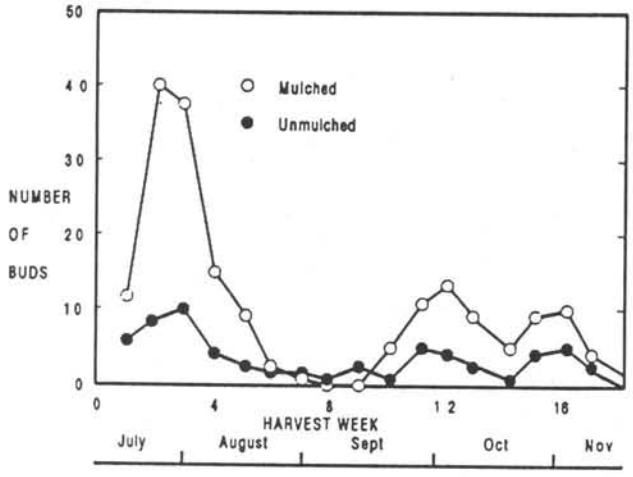

Figure 1. Distribution of Green Globe artichoke harvest in mulched and unmulched at Mt. Carmel in 1987.

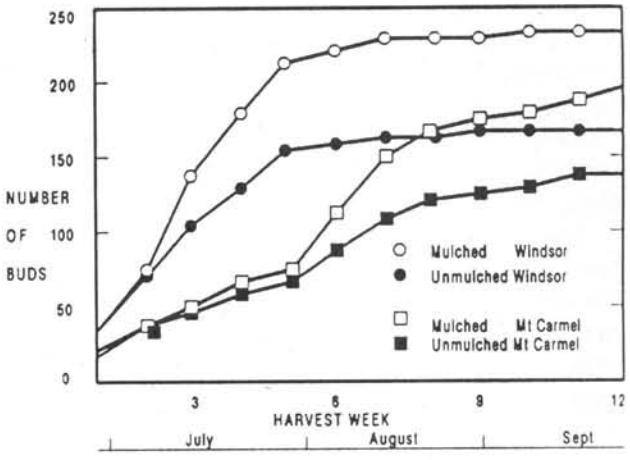

Figure 2. Cumulative yield of Green Globe artichokes in mulched and unmulched plots at Windsor and Mt. Carmel in 1988.

in late July (Figure 2). Fully 95% of the plants produced artichokes by this time due to vernalization alone. At Mt. Carmel only 45-54% of the buds in mulched and unmulched plots had been harvested by late-July. The increased yields of buds during harvest weeks 5-7 was due to simultaneous harvest of the second and third buds. Harvest of buds after week 10 at Mt. Carmel is largely due to treatment with gibberellic acid on July 25 (week 5). Figure 2 also shows that total yields of buds in mulched plants is greater than unmulched plants and is consistent with observations in 1987.

CONCLUSIONS

1. Artichokes of commercial quality can be produced from annual culture in Connecticut. The harvest period can begin as early as July 1 and can extend from mid-October until early-November depending upon occurrence of a killing frost in the mid-20's.

2. Winter protection is expensive, labor intensive, and likely has no place in commercial production (Hill 1987). For the homeowner with a few plants, removal of barren plants to a cool, sunny area indoors may suffice.

3. The distribution of harvest throughout the growing season depends upon vernalization to induce flower bud formation. Vernalization requires moist chilling of seed during germination and must be followed by cool temperature in the greenhouse and cold frame and mulching of plants after transplanting to the field to prevent devernalization. These techniques produced a large proportion of the harvest from early-July to mid-August.

4. In mid-July, treatment of barren plants with 100 parts per million gibberellic acid promoted bud formation with harvest from September to a killing frost. Although the harvest is extended by GA3 treatment, the yield of buds late in the season depends on the population of barren plants in mid-July. A high percentage of budding plants producing early in the season may preclude gibberellic treatment. If the plants are poorly vernalized, GA3 treatments in mid-July and mid-August will result in 20-35% of barren plants producing late in the season.

5. Among the 30 cultivars tested during 1985-1988, only Green Globe and Grande

Buerre consistently approached California yields. In 1988 trials, Romagna (Italy), Violetto di Bologna (Italy) and Talpiot (Israel) responded to vernalization and gibberellic acid treatment.

6. Artichokes seem best suited for retail sales in Connecticut's roadside and farmers' markets because the harvest generally occurs in the summer and early fall when wholesale prices are low. The advantage of Connecticut-grown artichokes is freshness and taste appeal. Connecticut farmers who have produced artichokes report that retail prices were independent of California wholesale prices at the time of harvest.

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