Evaluation of Propagating Stock and Practices for Annual Rhubarb Production

D.N. Maynard¹

Gulf Coast Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida, Bradenton, FL 34203

Additional index words. *Rheum rhabarbarum*, seed propagation, crown propagation, gibberellic acid

Abstract. Yield and quality of seed- and vegetatively propagated rhubarb (*Rheum rhabarbarum* L.) for annual production were evaluated for four seasons. Selection of 'Victoria' seedlings based on petiole color was not effective in increasing the proportion of red mature petioles. Yields from seed-propagated annual rhubarb were always higher than yields from single-bud crown divisions and from crown divisions in 1 of 2 years. Petiole color of vegetatively propagated rhubarb was always superior to that of seed-propagated rhubarb. GA applications increased early yield from single-bud divisions, but reduced petiole weight of early and total harvest of 'McDonald' rhubarb. Chemical name used: gibberellic acid (GA).

Rhubarb is grown for its large, fleshy petioles that are used mainly for sauces and pies. The plant is herbaceous, with an underground portion consisting of large, fleshy, and somewhat woody rhizomes and a fibrous root system. The leaves, which grow from the crown, provide the edible petioles.

Rhubarb is a cool-weather perennial vegetable. It does not thrive, and is rarely grown, where summer means exceed 24C or where winter means are higher than 4C. Temperatures below 10C are required to break dormancy. As a perennial, rhubarb is poorly adapted to the southern half of the United States (Pennell, 1976). Nonetheless, production of perennial rhubarb was, proposed by Walker (1905) in northern Arkansas at an elevation of 460 m, and methods for annual production in Louisiana were outlined by Tiebout (1941). Because there is no commercial rhubarb production in Florida and because it is rarely seen in home gardens, there appeared to be a greater chance of success with annual than with perennial production.

Rhubarb is normally propagated by crown divisions to maintain its clonal characteristics. Seed propagation is possible, but the resulting plants are variable and do not maintain the characteristics of the clone from which the seeds were obtained (Pennell, 1976).

Because of interest in alternative crops for local sales and shipping, these studies were initiated to determine methods for rhubarb crop establishment and production as an an-

nual crop in west-central Florida.

Rhubarb propagating material and cultural methods for production of annual rhubarb were studied for four growing seasons at the Gulf Coast Research and Education Center, Bradenton, Fla.

General procedures. Experiments were conducted on Eau Gallie fine sand (sandy, siliceous, hypothermic Alfic, haplaquod) with a spodic layer 90 cm deep. Raised beds were prepared in early October of each year with a portion of the fertilizer incorporated in the bed before final pressing and the remainder of the fertilizer placed in shallow grooves near the shoulders of the bed (Table 1). The beds were covered with white polyethylene in the first three seasons, whereas black polyethylene was used in the 1988-89 season. The plots were seepage-irrigated from irrigation/drainage ditches every seventh bed in the first three seasons and every sixth bed in 1988-89.

Transplants or crown divisions were set in holes punched in the polyethylene mulch at a 76-cm in-row spacing. Weed control between the mulched beds was by cultivation. Pesticides were not applied since no insects or diseases were apparent.

The rhubarb was harvested by periodically pulling selected petioles. The petioles were

cut to a uniform 25-cm length to conform to the minimum acceptable U.S. Dept. of Agriculture standards (Grange, 1966), counted, weighed, and separated into three grades based on petiole color. U.S. Fancy, U.S. No. 1, and U. S., No. 2 petioles are predominantly pink or red on at least three-fourths, one-half, or one-fourth, respectively, of their length. Some petioles were pithy late in the harvest period and were discarded before counting and weighing. The resulting yield and grade data were subjected to analyses of variance and means were separated by Duncan's multiple range test. Arcsin transformations of proportion data were done before analysis. Other cultural details are shown in Table 1 and specific methods for each season follow.

1985-86 Season. Seedlings from 'Victoria' seed were selected into classes having red, pink, or green petioles before transplanting. Unselected seedlings provided a fourth category. The 14 plant plots were replicated three times in a randomized complete-block design.

1986-87 Season. Two or three single-bud divisions of 'McDonald' rhubarb were prepared by sectioning each crown division as received from the nursery. The performance of plants from single-bud divisions, used to reduce costs for planting stock, was compared to that of plants from transplants from 'Victoria' and 'Detering' seeds. The 17-plant plots were replicated four times in a randomized complete-block design.

1987-88 Season. The performance of plants obtained from 'Victoria' transplants, 'McDonald' crown divisions, and 'McDonald' single-bud divisions was compared in 20-plant plots replicated four times in a randomized complete-block design.

1988-89 Season. Performance of rhubarb plants obtained from 'Victoria' and 'Roadstelige A Cote Rouge' (RACR) seeds was compared with 'McDonald' crown divisions and single-bud divisions with and without gibberellic acid (GA₃; Abbott Laboratories, North Chicago) applications of 8.5 mg/crown section as an aqueous drench after the sections were placed in the planting hole. Emergence of the crown divisions and single-bud divisions was monitored over 7 days. Each 12-plant plot was replicated four times and arranged in a randomized complete-block design.

Table 1. Cultural regimes for annual rhubarb production trials.

Regime	Season			
	1985-86	1986-87	1987-88	1988-89
Row spacing (m)	1.37	1.37	1.37	1.52
N-P-K (kg·ha ⁻¹)				
Incorporated	54-95-90	65-38-80	0-142-0	0-127-0
Banded	271-0-449	347-0-396	650-0-738	341-0-567
Seeding date	7 Aug.	4 Aug.	7 Aug.	15 Aug.
Transplanting date	7 Nov.	21 Oct. ^a	13 Nov.	28 Oct. ^a
First harvest	23 Jan.	31 Dec.	21 Jan.	3 Jan.
Last harvest	22 Apr.	17 Apr.	6 May	25 Apr.
No. of harvests	9	7	5	6

^aDivisions planted on 21 Nov.

^bDivisions planted on 2 Dec.

Received for publication 8 Nov. 1989. Florida Agr. Expt. Sta. Journal Series no. R-00261. Rhubarb crown divisions provided by Nourse Farms, South Deerfield, Mass., and 'Victoria' seedlings by Hunsader Farms, Bradenton, Fla., are gratefully acknowledged. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

¹Professor of Vegetable Crops.

Table 2. Yield, average petiole weight, and U.S. grade distribution of rhubarb in the 1985–86, 1986–87, and 1987–88 seasons with various plant sources.²

Season	Plant source	Yield (Mg·ha ⁻¹)	Petiole wt (g)	U.S. grade distribution (%)		
				Fancy	No. 1	No. 2
1985–86	Victoria seedling selection					
	Red petiole	18.7 a	65 a	57 a	28 a	15 b
	Pink petiole	17.1 a	66 a	43 a	36 a	21 b
	Green petiole	16.8 a	64 a	17 b	41 a	42 a
	Unselected	18.1 a	69 a	51 a	35 a	14 b
1986–87	Victoria seed	15.6 a	57 a	37 c	39 a	24 a
	Detering seed	4.1 c	55 a	65 b	29 b	6 b
	McDonald single-bud divisions	9.5 b	63 a	88 a	12 c	0 b
1987–88	Victoria seed	27.5 a	56 a	32 b	36 a	33 a
	McDonald crown divisions	14.1 b	61 a	56 a	42 a	3 b
	McDonald single-bud divisions	13.2 b	58 a	58 a	40 a	3 b

²Mean separation in columns within seasons by Duncan's multiple range test, $P = 0.05$.

Table 3. Yield and average petiole weight for early and total rhubarb production and U.S. grade distribution for total production of seed- and division-propagated rhubarb with and without GA treatment (1988–89 season).²

Source/treatment	Early production ^y		Total production		U.S. grade distribution (%)		
	Yield (Mg·ha ⁻¹)	Petiole wt (g)	Yield (Mg·ha ⁻¹)	Petiole wt (g)	Fancy	No. 1	No. 2
Victoria seed	1.8 b	48 ab	20.4 a	48 b	14 b	41 a	45 a
RACR seed	0.1 c	45 b	0.6 c	68 a	20 b	38 a	21 b
McDonald							
Crown division	2.0 ab	58 a	17.4 ab	43 b	69 a	26 a	5 b
Single-bud division	0.4 c	48 ab	14.1 b	44 b	62 a	32 a	6 b
Crown division + GA	2.4 a	39 b	17.0 b	32 c	69 a	26 a	5 b
Single-bud division + GA	1.9 b	39 b	16.1 b	34 c	60 a	34 a	6 b

²Mean separation in columns by Duncan's multiple range test, $P = 0.05$.

^yEarly production represents the first two of six harvests.

Yield and weight of rhubarb petioles from plants that were selected based on the petiole color of seedlings did not differ from each other or from plants of unselected seedlings (Table 2). Quality, as estimated by petiole color for U.S. grades, was similar from plants that were selected as having red or pink seedling petioles and from unselected seedlings. However, petioles from plants with green seedling petioles produced fewer Fancy and more No. 2 petioles.

Based on these results, it appears that it is difficult to select for mature red or pink petioles in the seedling stage. Previous research (Frazier et al., 1960; Martin, 1962) resulted in nonsignificant correlations between seedling and mature petiole color and between bud color and mature petiole color. Dickson and Tiessen (1965) found a highly significant positive correlation between plants producing green petioles and high yields, whereas in this study, yields did not differ among seedling selections, indicating that color observed in the seedling stage did not affect yield.

In the 1986–87 season (Table 2), rhubarb yields were highest from plants grown from 'Victoria' seeds and lowest from plants grown from 'Detering' seeds. Yields obtained from plants from 'McDonald' single-bud divisions

were intermediate to those from the seed-propagated plants. Petiole weight was similar, regardless of plant source. The highest proportion of red and pink petioles, expressed as U.S. grades, was produced by plants from 'McDonald' single-bud divisions, whereas the lowest proportion of such petioles was from plants from 'Victoria' seeds. Plants from 'Detering' seeds produced an intermediate and acceptable proportion of red and pink petioles, but yields were too low to make this plant source commercially acceptable.

Yields of plants from 'Victoria' seed were about twice those from 'McDonald' crown divisions or single-bud divisions in the 1987–88 season (Table 2). As in previous years, petiole weight was not significantly different among plants of different sources. U.S. grade distribution, based on mature petiole color, was significantly better from the vegetatively propagated 'McDonald' plants than from the seed-propagated 'Victoria' plants.

There was a tendency for emergence of 'McDonald' GA-treated divisions in the 1988–89 season to be earlier than untreated divisions; however, the effect was minimal since all plants emerged over 7 days (data not reported). However, early yields of single-bud divisions were enhanced by GA treatment,

but petiole weight was lower following GA treatment (Table 3). Accordingly, GA stimulated growth of buds so that more petioles were produced, but individual petiole weight could not be sustained. Total yields of rhubarb were highest from plants from 'Victoria' seed and 'McDonald' crown divisions. Yields from 'McDonald' crown divisions treated with GA and from 'McDonald' single-bud divisions with and without GA were similar to those obtained from 'McDonald' divisions but lower than those from seed-propagated 'Victoria' plants. Plants from RACR seed were apparently not well adapted to Florida conditions even though vigorous seedlings were transplanted to the field; more than 70% of the plants died by the end of the experiment. Petiole weight was similar from 'Victoria' seed-propagated plants and 'McDonald' vegetatively propagated plants, but significantly lower from GA-treated, vegetatively propagated plants. Color of 'McDonald' petioles, as reflected by U.S. grades and regardless of GA treatments, was superior to petiole color of the seed-propagated rhubarbs.

Gibberellic acid treatment of crown sections did not generally result in increased yields of field-grown rhubarb in contrast to what was reported previously (Tompkins, 1966) for forced rhubarb. Larger petiole size following GA treatments has contributed to increased yields of traditionally forced (Wittwer, 1968) and field-forced (Hemphill, 1985) rhubarb. In this study, however, petiole weight decreased following GA treatment. A likely explanation for this discrepancy is that the crown divisions and single-bud divisions used in this study provided less carbohydrate reserve than the intact crowns used in earlier experiments.

There are no commercial rhubarb plantings in Florida from which yield comparisons can be made. Experimental yields of plants from 'Victoria' seed ranged from 15.6 Mg·ha⁻¹ in the 1986–87 season to 27.5 Mg·ha⁻¹ in the 1987–88 season, with a 4-year average yield of 20.4 Mg·ha⁻¹. These yields can be compared with the 33.6 Mg·ha⁻¹ expected from green-petiole cultivars in Michigan (Helsel et al., 1981). Experimental yields from plants from 'McDonald' crown divisions were 14.1 Mg·ha⁻¹ in 1987–88 and 17.4 Mg·ha⁻¹ in 1988–89 for a 2-year average yield of 15.8 Mg·ha⁻¹. Average yields of red-petiole cultivars in Michigan are reported to be 28.5 Mg·ha⁻¹ (Helsel et al., 1981). In Ontario, rhubarb yields of 28 to 44.8 Mg·ha⁻¹ have been reported (Dickson and Tiessen, 1965; Wiebe and Zubeckis, 1969). Accordingly, yields of annual rhubarb in Florida are less than those of perennial rhubarb produced in the northern United States and in Canada. This difference is not unexpected because of the nature of the crop and should not be a deterrent to potential growers because of the likely demand for an out-of-traditional-season crop.

Temperature and rainfall deviated somewhat from the long-term averages. Most notable were three nights well below freezing

in the 1985–86 season, which caused minor leaf but no petiole damage. Mar. 1987 rainfall that was 200 mm above normal, and higher temperatures and lower rainfall than normal in the 1988–89 season. Annual rhubarb tolerated the range of environmental conditions that occurred during the four seasons.

Rhubarb responds to fertilizer applications and is believed to have a high nutritional requirement (Nonnecke, 1989). Although fertilizer rates were not a planned variable in these evaluations, application rates were adjusted in each crop season based on crop appearance the previous season; For example, plants in the 1986–87 season, when a low-P application was made, were not as vigorous as in the 1985–86 season and showed symptoms that were tentatively diagnosed as P deficiency late in the season. Accordingly, the amount of fertilizer applied was greatly increased in the 1987–88 season (Table 1), which resulted in increased vigor and yields. In 1988–89, fertilizer rates were reduced somewhat, which resulted in vigor similar to the 1987–88 crop, reduced yields of plants from ‘Victoria’ seeds, and increased yields of plants from ‘McDonald’ crown divisions and single-bud divisions. Symptoms presumed to be caused by P deficiency did not occur in the 1987–88 or 1988–89 seasons following elevated P applications.

Plant vigor declined each season in late April to early May. By mid-May, all above-ground plant parts were dead, and crowns excavated in June were decayed. Accordingly, rhubarb must be produced as an annual in Florida and other parts of the southern United States (Tiebout, 1941). Seed-propagated rhubarb, although variable in plant vigor and petiole shape and color, is suitable for direct-marketing and for home-garden use. Vegetatively propagated rhubarb having desirable petiole characteristics would be required for production of crops for shipping.

forced production as influenced by gibberellin, sucrose, and temperature. *Proc. Amer. Soc. Hort. Sci.* 89:472–477.

Walker, E. 1905. Rhubarb in Arkansas. *Arkansas Agr. Expt. Sta. Bul.* 86.

Wiebe, J. and E. Zubeckis. 1969. Rhubarb, culture and physiology, chemistry and technology. Ontario (Canada) Dept. Agr. & Food RP-11.

Wittwer, S.H. 1968. Chemical regulators in horticulture. *HortScience* 3:163–167.

Literature Cited

- Dickson, M.H. and H. Tiessen. 1965. Variability and potential in yields and color of forced rhubarb grown on organic soils. *Proc. Amer. Soc. Hort. Sci.* 86:547–551.
- Frazier, W.A., W.A. Sistrunk, J.R. Baggett, and L. Calvin. 1962. Correlation between certain seedling and mature plant characters in rhubarb. *Proc. Amer. Soc. Hort. Sci.* 76:492–494.
- Grange, G.E. 1966. United States standards for grades of rhubarb (field grown). U.S. Dept. Agr. Washington, D.C.
- Helsel, D., D. Marshall, and B. Zandstra. 1981. Rhubarb. Michigan Coop. Ext. Serv. Bul. E-1577.
- Hemphill, D.D., Jr. 1985. Forcing of field grown rhubarb with gibberellic acid. *HortScience* 20:123–124.
- Martin, F.W. 1962. Techniques and correlations in breeding rhubarb for forcing. *Proc. Amer. Soc. Hort. Sci.* 80:468–472.
- Nonnecke, I.L. 1989. Vegetable production. Van Nostrand Reinhold, New York.
- Pennell, J.T. 1976. Rhubarb production: U.S. Dept. Agr., Agr. Res. Serv. Lflt. 555.
- Tiebout, G.L. 1941. Rhubarb culture for Louisiana. Louisiana Ext. Circ. 214.
- Tompkins, D.R. 1966. Rhubarb petiole color and