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Forcing of Field Grown Rhubarb with Gibberellic Acid

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Abstract. **Injection of gibberellic acid (GA_3) into crowns of field grown rhubarb (*Rheum rhaponticum*) stimulated early petiole growth and increased total and marketable yields. The GA_3 treatment was most effective in late January and February, less effective in early March, and ineffective in June. Growth was stimulated by injection of 2.5 to 40 mg GA_3/crown, with 10 to 20 mg sufficient for optimal growth. Spray applications of GA_3 to soil-free buds and application through a trickle irrigation system did not increase rhubarb yield or earliness. Costs for the GA_3 injection treatment are very favorable compared to indoor forcing or to field forcing with clear polyethylene mulch.**

Two methods of forcing early harvest of rhubarb are in common use in the northwestern states. In the 1st method, crowns are removed from the field after the chilling requirement has been satisfied, starting in December (3, 6, 7). The crowns are placed in a heated, dark, forcing house, and gibberellic acid (GA_3) often is sprayed on the cleaned crowns to hasten petiole growth or replace the rest requirement of insufficiently chilled crowns (1, 8, 9). In addition to the expense of digging crowns and heating the forcing house to 11° to 15°C, this method results in only one crop per crown and requires yearly field replanting. The 2nd method involves field forcing with clear plastic mulch (CM). The CM is placed over the rows as the buds that are just beginning to swell, usually early in February. This method is less expensive than indoor forcing, but CM costs have increased in recent years and disposal of the used CM is an additional cost.

A spray of GA_3 increases yield and earliness of indoor forced rhubarb (5, 8). Wittwer and Bukovac (10) reported that GA_3 increased petiole length when applied to rhubarb foliage, but Case (1) reported no yield increase after field application of GA_3. The following trials were undertaken to determine if direct injection of GA_3 into crowns would increase earliness or yield of rhubarb in the field.

In each experiment, 10 ml of treatment solution were injected into the base of 3 buds/crown (3–4 ml/bud) with a 1 mm (O.D.) veterinary syringe. To prevent stoppage of the syringe by plant material, a 4 mm (O.D.) pointed probe was used to form the injection cavity.

In 1981, treatments of a distilled water check and 8 or 40 mg/crown of the K salt of GA_3 were applied to 'Crimson' rhubarb on 20 Feb. Plots consisted of 4 crowns each, with 5 replications of each treatment. Petioles were harvested on 31 Mar.

In 1982, Expt. 1, 2-crown plots (4 replicates) of 'Crimson', 'German Wine', and 'Victoria' rhubarb were injected on 12 Feb. with either distilled water, or 5 or 20 mg GA_3/crown. In Expt. 2, 2-crown plots (4 replications) of 'Victoria' were injected with water or 20 mg GA_3/crown on 12 Feb. and were immediately covered with 0.1 mm × 1.9 m CM. In Expt. 3, 2-crown plots of 'Victoria' were sprayed with water, and soil and decayed plant material were removed to expose the buds. The crowns were treated on 12 Feb. with a spray of water or aqueous solutions of 5 or 50 mg GA_3/crown with 4 replications of each treatment. In Expt. 4, 2-crown plots (6 replications) of 'German Wine' were injected with water or GA_3 at 20 mg/crown on 11 June, immediately following harvest of all petioles. Expt. 2 was harvested on 18 Mar., Expt. 1 on 8 Apr., Expt. 3 on 23 Apr., and Expt. 4 on 25 July.

In Expt. 1, GA_3 was applied in 1983 to 'Crimson' rhubarb through a trickle irrigation system at about 0, 28, 56, or 84 mg/crown on 25 Jan., 8 Feb., and 1 Mar. About 400 ml of solution was applied per crown and allowed to soak into emerged buds and soil immediately above each crown. Plot size was 6 crowns, with 5 replications of each treatment. In Expt. 2, GA_3 was injected at 0, 10, or 20 mg/crown on 25 Jan., and 0, 2.5, 5, 10, and 20 mg/crown on 8 Feb. and 1 Mar. Each plot consisted of 3 crowns with 5 replications of each treatment. Marketable petioles were harvested from both experiments on 15 Mar. for the 1st 2 application dates and 30 Mar. for the 3rd application date.

For all experiments, herbicide and fertilizer applications were in accord with standard grower practice. Plantings were not irrigated. A randomized complete block design was used for all experiments.

In 1981, GA_3 injection at early bud swell increased total yield, number of petioles/crown, and mean petiole weight of 'Crimson' rhubarb at a single early cutting (Table 1). In 1982 (Expt. 1), injection of 20 mg GA_3/crown at early bud swell increased total and marketable yield of 'Crimson', 'German Wine', and 'Victoria' rhubarb, but the 5 mg rate increased yield only of 'Victoria' and 'German Wine' (Table 1). As in 1981, GA_3 tended to increase the number of petioles harvested and mean petiole weight. 'Victoria' produced much higher marketable yields than did the other 2 cultivars.

In Expt. 2, 1982 (data not shown), an injection of 20 mg GA_3/crown into 'Victoria' rhubarb increased total yield from 2.4 to 4.0 kg, mean petiole weight from 28 to 49 g, and number of marketable petioles/crown at 1st harvest from 11 to 36, when both control and GA_3-treated crowns were covered with CM. Harvest was 3 weeks earlier with CM and CM plus GA_3 than for the control and GA_3-treated crowns which were not covered with CM. Thus, a direct time comparison with nonmulched plants is not possible. It is evident, however, that large increases in yield or earliness can be achieved with GA treatment even in the presence of CM.

Table 1. Effect of GA_3 injection on yield parameters of 3 field grown rhubarb cultivars, 1981 and 1982, Expt. 1.

Cultivar and year	GA_3 rate, (mg/crown)	Total yield (kg/crown)	No. of petioles/crown	No. of marketable petioles/crown	Mean petiole wt. (g)
'Crimson'	0	0.7 c[z]	36 b	0 b	19 a
1981	8	1.3 b	41 ab	9 a	32 b
	40	1.8 a	51 a	12 a	36 b
Significance[y]		**	*	**	**
'Crimson'	0	3.9 b	70 b	28 b	57
1982	5	3.8 b	69 b	29 b	55
	20	5.0 a	82 a	38 a	61
Significance[y]		*	*	*	NS
'German Wine'	0	1.6 c	66 b	10 c	24 b
1982	5	2.2 b	80 b	29 b	27 ab
	20	3.8 a	124 a	54 a	31 a
Significance[y]		**	**	**	*
'Victoria'	0	3.0 c	111 b	30 c	27 b
1982	5	4.2 b	123 ab	47 b	34 ab
	20	5.9 a	147 a	78 a	40 a
Significance[y]		**	*	**	*

[z]Mean separation within columns and cultivars by Duncan's MRT, 5% level.
[y]**, *, [NS]F test significant at 1% and 5% levels, and nonsignificant, respectively.

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Table 2. Effects of GA_3 sprays and late spring GA_3 injections on yield parameters of field grown rhubarb, 1982, Expt. 3 and 4.

Treatment	GA_3 rate (mg/crown)	Total yield (kg/crown)	No. of petioles/crown	No. of marketable petioles/crown	Mean petiole wt. (g)
Spray treatment					
Control	0	6.6	116	65	57
Spray (12 Feb.)	5	6.8	120	68	57
Spray (12 Feb.)	50	7.2	113	69	64
Significance[z]		NS	NS	NS	NS
Injection treatment					
Control	0	3.3	99	41	33
Injected (11 June)	20	3.4	98	46	35
Significance	NS	NS	NS	NS	NS

[z]NS No significant differences, $P \leq 0.05$.

Cleaning of crowns to remove soil and dead foliage markedly increased yield of indoor forced rhubarb sprayed with GA_3 (5, 6). However, GA_3 sprays (Expt. 3, 1982) of sufficient volume to thoroughly wet the surface of previously cleaned and exposed buds had no effect on yield of field grown rhubarb (Table 2). The high yields obtained from check plants in this experiment probably were due to the comparatively late harvest date. An injection of GA_3 in June, following the 1st cutting (Expt. 4, 1982), had no effect on yield of the 2nd cutting of 'German Wine' rhubarb (Table 2).

In 1983 (Expt. 1), application of GA_3 through a trickle irrigation system had no effect on yield or earliness (data not shown). These results, in combination with results of the spray treatments in 1982, indicate that GA_3 must be injected into buds or crowns of field-grown rhubarb to be an effective growth promoter.

Expt. 2 in 1983 was designed to determine more closely the optimal rate and time of application. Injection of GA_3 increased marketable yield of 'Crimson' rhubarb when applied on 25 Jan. or 8 Feb. (Table 3). Yield of marketable petioles increased linearly with rate of GA_3 application up to 20 mg/crown for both dates (25 Jan., $r = 0.94$, F = 15.80, $P \leq 0.01$; 8 Feb., $r = 0.87$, F = 17.81, $P \leq 0.001$). When applied on 1 Mar., GA_3 also tended to increase yield but the effect was not significant due to increased growth of check petioles (Table 3). The greatest difference in yield between the check and 20 mg treatments occurred for the 8 Feb. application. This difference was not expected, since the 25 Jan. and 8 Feb. plots were harvested on the same day. The cumulative chilling degree days (CCDD) for 10 cm soil depth, using a 10°C base (6, 8), were calculated starting on 1 Oct. 1982. By 25 Jan., the CCDD accumulation was 431°, far more than the 167 to 244° needed to break the rest period in other cultivars (4, 8). Thus, the greater response of rhubarb to GA_3 on 8 Feb. compared to 25 Jan. probably is not related to the chilling requirement. Buds were better exposed on 8 Feb. than on 25 Jan., possibly resulting in more efficient placement of the GA_3. Soil and air temperatures also were more conducive to petiole growth than on the earlier date. Timing of application based on bud emergence rather than calendar date or CCDD may be the practical choice for the grower.

The GA_3 injection treatments have produced significant petiole production up to 1 month earlier than normal, thus extending the harvesting season from the normal 2 months (7) to as much as 3 months. Applications should be made at 1st sign of bud emergence or as soon thereafter as is practicable to move equipment through the field. The effective rates of 10 to 20 mg/crown are similar to those found most effective (5 to 100 mg/crown) for increasing the yield or earliness of indoor forced rhubarb (2, 4, 5, 8). Costs are much lower than for in-field forcing with CM. At a plant population of 10,000/ha and using 20 mg/crown, the cost for GA_3 would be about $250/ha compared to a CM cost of at least $625/ha for the same field.

The syringe injection technique would not be practical on a large scale, but an injection device suitable for treating 2 to 3 ha/day has been developed by area growers. Some reduction in marketable yield may result from mechanical scarring of petioles by the injectors. However, the proportion of petioles culled because of mechanical damage has never exceeded 4% in these trials. Since rhubarb usually is marketed with leaf blades removed, mechanical damage to the leaf and the pale color of the GA_3-treated leaf blades would not reduce marketability. The long term effects of repeated GA_3 injections on crown productivity and disease incidence have not been fully evaluated.

Table 3. Effects of rate and timing of GA_3 injection on yield parameters of field grown 'Crimson' rhubarb, 1983, Expt. 2.

Application date	GA_3 rate (mg/crown)	Yield of marketable petioles (kg/crown)	No. of marketable petioles/crown	Mean petiole wt. (g)
25 Jan.	0	0.31	7	45
	10	0.71	13	53
	20	0.87	17	51
Significance[z]		Linear (**)	Linear (**)	NS
8 Feb.	0	0.22	9	39
	2.5	0.93	21	44
	5	1.08	21	52
	10	1.30	24	53
	20	1.53	29	52
Significance		Linear (**) Quadratic (*)	Linear (**)	Linear (*) Quadratic (**)
1 Mar.	0	1.32	18	75
	2.5	1.65	20	82
	5	2.22	25	88
	10	2.04	25	83
	20	2.08	24	86
Significance		NS	NS	NS

[z]**, *, NSSignificant at 1% and 5% levels, and nonsignificant, respectively.

Literature Cited

1. Case, M.W. 1968. Use of gibberellic acid on rhubarb for forcing. Ninth Prog. Rpt. Expt. Husb. Fms. Expt. Hort. Stats., p. 61–63.
2. Case, M.W. 1970. Results justify experiments with gibberellic acid on forced rhubarb. Grower 74:397–398.
3. Hepler, J.R. 1928. The effects of ether and various temperatures in forcing rhubarb. Proc. Amer. Soc. Hort. Sci., 25:65–70.
4. Karsten, J.E. and W.A. Wiebosch. 1971. Vroeger forceren van rabarber mogelijk. Groenten en Fruit 27:875.
5. Laban, M.C. and C.J. Van der Ven. 1968. Vervroegd forceren van rabarber mogelijk met "gibberellinazuur" (GA_3). Groenten en Fruit 24:847–849.
6. Loughton, A. 1960. The effect of low temperatures before forcing on the behaviour of rhubarb. Expt. Hort. 4:13–19.
7. Pennell, J.T. 1978. Rhubarb production. USDA. Leaflet No. 555. Published by the U. S. Government Printing Office: 1978, 0-271-339. Washington, D.C. 20402.
8. Tompkins, D.R. 1965. Rhubarb rest period as influenced by chilling and gibberellin. Proc. Amer. Soc. Hort. Sci. 87:371–379.
9. Tompkins, D.R. 1966. Rhubarb petiole color and forced production as influenced by gibberellin, sucrose, and temperature. Proc. Amer. Soc. Hort. Sci. 89:472–477.
10. Wittwer, S.H. and M.J. Bukovac. 1957. Gibberellin and higher plants. X. Field observations with certain vegetable crops. Mich. Agr. Expt. Sta. Quart. Bul. 40:352–364.