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Factors Influencing Flowering of Rhubarb[1,2]

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Abstract. Flowering of rhubarb (*Rheum* spp.) was affected by plant age and vernalization temperature and by vernalization time in young crowns. Year-old crowns flowered after storage at 0°C or 5°C for 3 months or more. All 19 week-old crowns flowered after storage at 0°C for 3 months or more and some flowered after storage at 5°C. The 16 week-old crowns flowered only after 4½ and 6 months storage at 0°C. None of the 13 week-old crowns flowered. There was no flowering of crowns stored at 10°C regardless of age or length of storage. Growing temperature and photoperiod following vernalization did not influence flowering.

Growing instructions for rhubarb in temperate regions always discuss removal of flower stalks which develop each spring, but this is never mentioned in articles on forced rhubarb. Sayre (3) and others (2, 6, 7) reported that 6-8 weeks at or below 10°C broke dormancy for leaf growth and gave optimum yields of forced rhubarb, but no mention was made of flowering. Other rosette plants, both biennial and perennial, flower only after exposure to low temp for some period of time (8). These considerations led to this study of flowering of rhubarb plants.

Materials and Methods

Experiment 1 (1969-1970).

A 3 x 4 x 2 x 2 factorial with 5 plants per treatment for a total of 240 plants was designed to evaluate several factors. Seeds of rhubarb cv. Victoria were planted on 3 different dates in peat pots filled with a peat-vermiculite media. Seedlings were transplanted to 6-inch clay pots and grown in the 27/21°C greenhouse. At 8, 12, and 16 weeks of age, some plants were transferred to a 10/5°C day/night greenhouse for vernalization periods of 40, 60, and 80 days. Other plants remained in the warmer greenhouse as checks. After the appropriate vernalization periods, plants were returned to 27/21°C and 21/15°C greenhouse and grown under photoperiods of either 8 or 14 hr. Another group of 24 plants, when 24 weeks old, were stored at 0° for 5 months and then returned to the 21/15°C greenhouse.

Experiment 2 (1970-1971).

The plants from Experiment 1 and new seedlings started on different dates were grown in the field on Eel silt loam during the summer of 1970. All crowns were dug on October 28 when 13, 16 and 19 weeks (Fig. 1), and 1 year old. The roots were trimmed and crowns washed. Ten crowns of each age were planted in 12-inch pots in the greenhouse immediately. The remaining roots were placed in perforated plastic bags with vermiculite to prevent desiccation (7) during storage at 0°C, 5°C, and 10°C for 3, 4½, and 6 months. After the appropriate storage periods, the stored crowns were potted and grown in the greenhouse at 27/21°C and 21/15°C. Initially, there were 5 crowns in each treatment but some of the crowns decayed in storage or after potting. Observations were made every 2 weeks on the appearance and the number of seedstalks and flowering. Width and ht of the foliage was measured at the end of the experiment.

Experiment 3 (1971).

Upon termination of Experiment 2, the crowns previously stored for 3 months were removed from the pots, trimmed and stored at 0°, 5° and 10°C. In addition, some crowns of the vegetative, non-vernalized control plants were stored at 0°C. These crowns were now approx 1 and 2 years of age. After 4½ months storage, the crowns were returned to the 21/15°C greenhouse and grown under either 8 or 14 hr photoperiods. Both groups were exposed to natural daylight from 8 am to 4 pm and then covered with black shading cloth. Additional illumination for the 14-hr day was provided by incandescent lights giving 150 ft-c at plant level.

Results and Discussion

In Experiment 1 the 8 to 16 week-old crowns transferred to the 10°/5°C greenhouse for 40 to 80 days failed to flower. However, when the 24 week-old crowns stored at 0°C for 5 months were planted in the greenhouse, seedstalk elongation was evident within a week. These observations led to a reconsideration of the variables and design of the second experiment.

In Experiment 2, flowering was significantly affected by crown age (Table 1A) and vernalization temp (Table 1B), but not by vernalization time (Table 1C). No flowering occurred in 13 week-old crowns. More seedstalks were formed in the older crowns (Table 1A), reflecting the larger number of buds capable of induction. The younger crowns developed 8-12 leaves before flowering whereas the older crowns flowered after only 3-4 leaves (Fig. 2). As the vernalization temp was lowered (Table 1B) more crowns flowered and the number of seedstalks per crown increased. Storage at 10°C was sufficient to break dormancy for new leaf growth in agreement with results of Loughton (2) but did not induce flowering. No difference in rate or percentage of flowering resulted from greenhouse growing temp after vernalization, indicating that rhubarb was not devernalized by the 27/21°C temp (Table 1D).

The interaction of crown age and vernalization temp and time (Table 2) provides some information on the juvenile period and the optimum temp for flower induction. The 19 week-old crowns all flowered after storage at 0°C but only part of them

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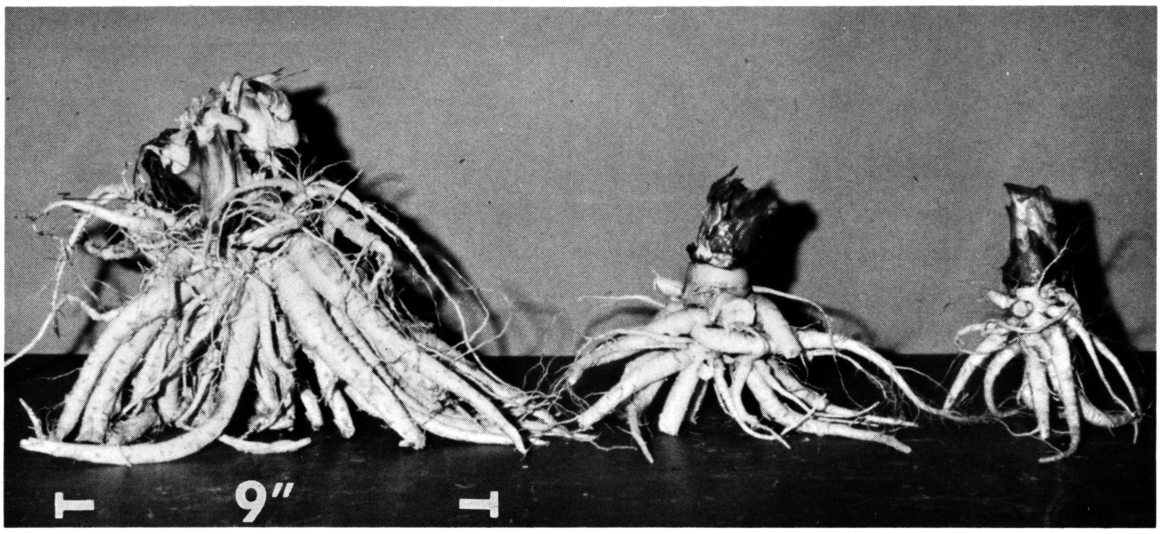

Fig. 1. Relative rhubarb crown size at 3 ages (left to right: 19, 16, and 13 weeks).

flowered after 5°C. Similarly part of the 16 week-old crowns flowered after storage at 0°C but none flowered after 5°C storage. The more effective floral induction in rhubarb at 0°C than at 5°C differs from many other plants, notably, cabbage (1) and onions (5) where the opposite was true.

All of the 13 week-old crowns were juvenile, some of the 16 week-old crowns had passed through the juvenile stage and most of the 19 week-old crowns were adults. The response to vernalization time and temp during the transition stage at the end of the juvenile period was typical of such plants as cabbage (1) and Brussels sprouts (4). Termination of the juvenile period is a function of both age and size. It is not possible to determine which factor was involved in those treatments where some of the plants flowered. The flowering crowns may have been larger when dug or had a shorter juvenile period compared to the non-flowering crowns in this heterogenous seedling population. The measurement of leaf area per plant did not adequately reflect differences in crown size prior to vernalization treatments. As reported by Wiebe (7) a more accurate measurement would be the wt of the crowns immediately after harvest.

Evaluation of the results in Table 2 also explain the lack of flowering in Experiment 1. In the first experiment, the vernalization temp (5-10°C greenhouse) was too high and the vernalization period (80 days) too short for even the oldest (16 week-old) plants studied.

Photoperiod did not affect the percentage (Table 3) or rate of flowering. Floral induction did not occur again at 10°C.

Table 1. Main effects of crown age, vernalization temperature, vernalization time, and growing temperature on flowering, seedstalks formed per crown, and leaf spread per crown (Unequal crown number resulted from decay of some of the crowns).

A. Crown age	No. of crowns	Percent flowered	Avg. no. seedstalks	Avg. leaf spread (in^2)
1 year	70	67	2.8	622
19 weeks	73	55	1.4	430
16 weeks	65	17	1.4	491
13 weeks	60	0	–	375
B. Vernalization temp. (°C)				
0	94	64	2.5	430
5	90	42	1.3	493
10	84	0	–	517
C. Vernalization time (months)				
3	49	35	1.8	560
4½	115	35	1.7	469
6	104	39	2.5	410
D. Growing temp. day/night (°C)				
27/21	138	36	1.9	507
21/15	130	38	2.2	452

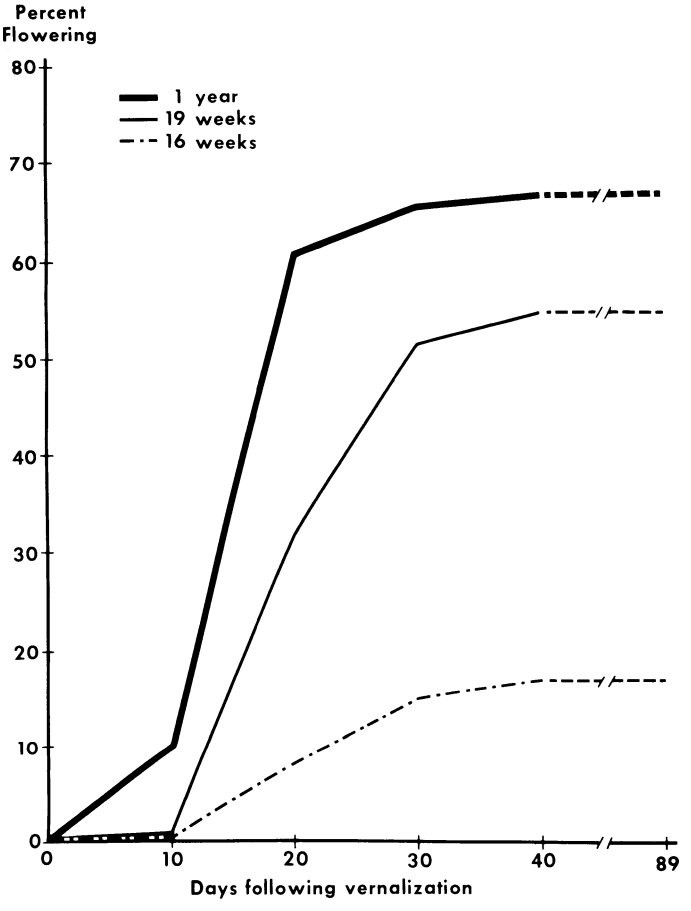

Fig. 2. Rate of flowering in rhubarb crowns of different ages as measured by number of days following vernalization when the first seedstalk was 10-15 cm tall.

Table 2. Interaction of crown age, vernalization temperature, and vernalization time on flowering of rhubarb. (Note: the 13-week-old crowns and all crowns stored at 10°C did not flower).

Vernalization time (months):	3		4½		6	
Vernalization temp. (°C):	0°	5°	0°	5°	0°	5°
Crown age	%	%	%	%	%	%
1 year	100	100	100	100	100	100
19 week	100	80	100	50	100	60
16 week	0	0	67	0	56	0

Crowns (check + 0°C) which had remained vegetative up to this period in time, flowered as did the other crowns which were vernalized a second time.

The check plants, which were potted in the greenhouse immediately upon removal from the field and received no cold treatment, remained vegetative during Experiments 2 and 3, almost 2 years.

In consideration of the factors studied in these experiments, flowering in rhubarb was mainly influenced by crown age and vernalization temp. Flowering did not occur in 13 week-old crowns or when vernalized at 10°C. Length of vernalization was critical only in 16 week-old crowns. Greenhouse growing temp and photoperiod had no influence on percentage or rate of flowering. In order to induce flowering in rhubarb, clearly a longer time and lower temp was needed than that necessary to break dormancy for new leaf growth.

Table 3. Effect of photoperiod following vernalization for 4½ months at several temperatures on the flowering of rhubarb grown in the 21/15°C greenhouse.

	Photoperiod			
	8 hours		14 hours	
Crown storage temp.	No. of crowns	Percent flowered	No. of crowns	Percent flowered
Check + 0°C	7	100	7	100
0°C	10	100	8	100
5°C	8	100	10	100
10°C	9	0	8	0

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