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Pinching Forced Tuberous-rooted Dahlias[1]

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Abstract. **Pinching of forced tuberous-rooted *Dahlia* 'Park Princess' and 'Miramar' was evaluated as a method for increasing flower production and plant quality. Pinched plants produced more flowers, flowered later, had smaller flowers, and were taller than unpinched controls. On an individual plant basis, pinching at node 4 generally gave the best results, while pinching at node 2 resulted in the greatest delay and fewest flowers. The more distal the pinch, the greater the number of laterals formed on both cultivars and the higher the percent of laterals flowering on 'Park Princess'. On a population basis, pinching only those plants with a single strong shoot at node 3 or 4 resulted in the best compromise between increased flower production and the deleterious delayed flowering and increased plant height.**

Recent efforts to develop techniques for forcing dahlias from tuberous-root clumps of asexually propagated, established garden cultivars have resulted in several cultivars being suggested for commercial use (5). Proper fertilization and temperature regimes, along with ancymidol for height control, are required to produce quality plants (6, 7). The naturally increasing spring photoperiods are optimal for flower initiation and development (7).

During these studies (5, 6, 7), each shoot formed a terminal flower and a few lateral flower buds, however, the number of shoots developing from each clump varied from 1 to 4 or more. Therefore, while some plants had several flowers and buds, others had only a single flower and a few buds.

Increasing the number of flowers on a plant by pinching to increase the number of lateral branches is a common floricultural practice (8, 11, 14). Also, garden dahlias are often pinched to increase the number of flowers (9). The objective of this study was to evaluate the effects of pinching on tuberous-rooted dahlias under greenhouse forcing conditions.

Materials and Methods

The shipping, handling, and forcing of dahlia clumps were the same as previously described (2). Except where specified, ancymidol (0.5 mg/15 cm pot) was applied in 100 ml of solution 14 days after planting.

A flower was considered open when a series or a few florets around the outside of the capitulum had reflexed enough that the midportion of the ligule was pulling back from the inner florets. This was several days after the first color developed in the bud and about 4 days before the flower head reached its max diameter. The flowering date for a plant was the opening of the first flower. Flower diameter and number of open flowers was determined 7 days later.

Because the position of the change from simple to compound leaves varies within and between cultivars (1) the position of the pinch was determined by node number rather than leaf type. The first leaf-like structure at the base of the stem of both cultivars 'Park Princess' and 'Miramar' was counted as a leaf if there was a distinct internode below it or if it was 1 cm or longer.

Results and Discussion

Experiment 1. In 1976, 500 clumps each of 'Park Princess' and 'Miramar' were planted Feb. 25 and 26, respectively. The rate of shoot growth after planting was variable, but as the plants reached the stage where 2 leaf pairs had separated, they were segregated according to plant size and no. of shoots per plant. Based on shoot number, the groupings for 'Park Princess' were single (1 shoot), double uneven (2 shoots, 1 more vigorous than the other), double even (both shoots approx same size), and triple (shoot size more uniform than double uneven). The groupings for 'Miramar' were single, double uneven, and double even.

Each test was a randomized complete block. The treatments were number of shoots per plant and location of the pinch (Tables 1 and 2). Blocking was against the reported effects of the varying early shoot growth (3). There were 5 pots per replication with 3 and 4 replicates, respectively, for 'Miramar' and 'Park Princess'.

Regardless of shoot number or pinch position, pinched 'Park Princess' were about 8-10 cm taller and 8-12 days later in flowering than unpinched plants (Table 1). Flowering of unpinched triples was delayed compared to the unpinched single and double uneven plants. Pinched triples were also

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Table 1. The effects of shoot number and pinching node on the development of 'Park Princess'.

Shoot no.	Pinched above node	Days to flower	Plant[z] ht (cm)	No. of[z] flowers per plant	Diam of[z] first flower (cm)
1	No pinch	59.2g[w]	39.5cd	2.4fg	14.1a
	2	71.3bc	47.6a	3.4ef	13.3bc
	3	68.2d	46.4ab	4.4cd	12.9cd
	4	70.2cd	46.2ab	5.5b	12.8cd
2 uneven[y]	No pinch	61.2fg	37.0d	2.2g	14.1a
	3	69.0d	47.4a	4.5cd	13.1bcd
	4	69.2cd	48.2a	4.2de	13.1bcd
2 even[x]	No pinch	61.8ef	39.6cd	3.2f	13.7ab
	3	70.3bcd	49.2a	5.7ab	13.0bcd
	4	71.9b	48.6a	6.4a	13.0bcd
3[x]	No pinch	63.4e	42.6bc	3.0fg	14.0a
	3	72.4ab	47.5a	5.1bc	12.5d
	4	74.3a	48.5a	5.7ab	12.6d

[z]Determined 7 days after opening of first flower.

[y]Only the strongest shoot was pinched.

[x]All shoots were pinched.

[w]Mean separation within columns by Duncan's multiple range test, 5% level.

Table 2. The effects of shoot number and pinching node on the development of 'Miramar'.

Shoot no.	Pinched above node	Days to flower	Plant[z] ht (cm)	No. of[z] flowers per plant	Diam of[z] first flower (cm)
1	No pinch	70.3d[w]	49.3c	2.0bc	14.7a
	2	85.5a	58.5ab	1.8c	14.4ab
	3	75.1c	54.0abc	2.0bc	14.9a
	4	74.6c	54.6abc	2.7ab	14.6a
	5	79.3b	54.4abc	3.1a	13.7b
2 uneven[y]	No pinch	71.9d	51.9bc	2.0bc	15.0a
	4	76.0b	55.0abc	2.7ab	14.4ab
2 even[x]	No pinch	72.0d	53.9abc	2.9a	14.2ab
	4	75.4c	59.5a	3.1a	14.4ab

[z]Determined 7 days after opening of first flower.

[y]Only strongest shoot was pinched.

[x]All shoots were pinched.

[w]Mean separation within columns by Duncan's multiple range test, 5% level.

delayed compared to singles and double unevens pinched at node 3 or 4.

In all cases, pinching 'Park Princess' at node 3 or 4 resulted in about twice as many flowers per plant compared to unpinched plants (Table 1). Pinching also tended to reduce flower size as has been reported for garden dahlias (9). However, since the flowers were still relatively large at 12.5 to 13.1 cm, the reduced size was not considered commercially important.

As with 'Park Princess', pinching 'Miramar' delayed flowering in all cases (Table 2). Pinching at node 3 or 4 resulted in the least delay. For 'Miramar' plant height (except for pinching at node 2), flower number, and flower size were not greatly affected.

Data were obtained on the development of laterals on pinched single and double uneven plants (Table 3). For both cultivars, the more distal the pinch the more laterals that developed, but 'Park Princess' formed more laterals than 'Miramar'. 'Miramar' formed branches at the 2 most distal nodes only, while 'Park Princess' produced some branches at the 3rd node below the pinch. In all cases, 2 branches developed at the most distal remaining node. Therefore, the within and between cultivar differences in the number of branches developed were caused by the differences in the number of branches produced at the 2nd and 3rd nodes below the pinch.

On most pinched plants, the first flower to open was on a lateral arising from the most distal node, but occasionally with 'Park Princess' the first lateral to flower was at the 2nd node below the pinch. With 'Miramar', the more distal the pinch the higher the % of laterals flowering at the most distal node, but the position of the pinch did not affect the flowering of the laterals at the 2nd node below the pinch. The opposite was true for 'Park Princess'. The position of the pinch did not affect the flowering of laterals at the most distal remaining node, but the more distal the pinch the higher the % of laterals flowering at the 2nd node below the pinch (Table 3).

Pinching caused a greater increase in flowering on 'Park Princess' than on 'Miramar'. This was due to the greater number of lateral branches formed by 'Park Princess'. In addition, 'Miramar' normally averages about 1.5 shoots per clump, while 'Park Princess' averages more than 2. This indicates a possible correlation between the number of shoots a cultivar produces and its branching and flowering after pinching.

Konishi and Inaba (10) pinched rooted cuttings above the 3rd node and by disbudding allowed only laterals from node 1 or 3 to develop. They found that the laterals from node 1 flowered earlier and produced higher quality flowers than the laterals from node 3. However, our data indicate that for pinched dahlias grown from clumps the highest quality plants are formed by laterals from nodes 3 and 4.

Experiment 2. Because of increased plant height due to pinching, ancymidol applied as a drench and/or a foliar spray was evaluated on both pinched and unpinched 'Park Princess' with treatments as described in Table 4. The clumps were planted May 12, 1978, and only the first shoot was allowed to develop on each plant. Only plants which were large enough to be pinched at node 3 (26 days after planting) were used. The spray was applied 33 days after planting at the rate of 0.3 mg/pot as a 100 ppm solution. There were 15 plants per treatment in a randomized complete block design with 3 replications.

As in the previous experiment, pinching delayed flowering. However, ancymidol applied as either a drench or spray did not affect the days to flower.

For plants receiving only the ancymidol drench, the pinched plants (treatment 4) were about 13 cm taller than unpinched plants (treatment 3). Likewise, for plants not receiving ancymidol, the pinched plants (treatment 2) were taller than unpinched plants (treatment 1). Therefore, the elongation of the laterals, which resulted in the increased height of pinched plants, appeared to be a natural growth response to pinching rather than a lowering of the amount of ancymidol per growing shoot.

Pinching increased peduncle length in all cases, and the ancymidol drench reduced peduncle length on pinched (treatments 4 vs. 2) and unpinched (treatments 3 vs. 1) plants. Mastalerz (12) reported that foliar sprays of ancymidol reduced dahlia peduncle length if applied before the peduncle elongated above the foliage. Ancymidol was shown to reduce the elongation of the last internode of the tulip scape (13), but Carlson's (4) data indicated that while ancymidol reduced the total ht of seed geraniums it did not inhibit peduncle elongation.

In this experiment, the postpinch ancymidol sprays significantly reduced the height of pinched plants (treatments 4 vs. 6). However, in 2 subsequent tests with ancymidol, daminozide, and chlormequat as postpinch sprays on 3 cultivars, no consistent benefits were observed.

Table 3. Development of lateral branches at each node after pinching 'Park Princess' and 'Miramar'.[z]

Cultivar and node pinched above	Avg no. of laterals per node at node					No. of laterals per plant	% of laterals flowering at node					% of laterals flowering
	1	2	3	4	5		1	2	3	4	5	
Park Princess												
2	1.3	2.0	–	–	–	3.3	29	94	–	–	–	68
3	0.1	1.4	2.0	–	–	3.5	0	52	97	–	–	78
4	0	0.3	1.9	2.0	–	4.2	–	8	71	94	–	83
Miramar												
2	0.1	1.9	–	–	–	2.0	0	62	–	–	–	58
3	0	0.3	1.9	–	–	2.2	–	25	79	–	–	72
4	0	0	0.7	2.0	–	2.7	–	–	30	93	–	76
5	0	0	0	1.3	2.0	3.3	–	–	–	20	97	66

[z]Data from single and double uneven plants.

Table 4. Effects of pinching and ancymidol on development of single shooted 'Park Princess'.

No.	Treatments: Ancymidol[z] Drench	Ancymidol[z] Postpinch spray	Pinch	Days to flower	Plant ht (cm)	Peduncle length (cm)
1	No	No	No	56.8b[y]	45.8b	13.2b
2	No	No	Yes	70.7a	59.3a	17.0a
3	Yes	No	No	55.7b	23.6e	6.6de
4	Yes	No	Yes	72.0a	36.3c	10.7bc
5	Yes	Yes	No	57.3b	21.2e	5.9e
6	Yes	Yes	Yes	71.7a	31.3d	8.6c

[z]Drench at 0.5 mg/15 cm pot; spray at 0.3 mg/pot.

[y]Mean separation within columns by Duncan's multiple range test, 5% level.

Experiment 3. In experiment 1, the effects of the location of the pinch and shoot number were determined. The experimental design was set up to block against the effects of the variable initial shoot growth. Therefore, in order to determine the effects of pinching on an unrestricted population, no constraints were imposed in experiment 3 except that a maximum of 3 shoots were allowed to develop on any plant.

In 1977, 'Park Princess' and 'Miramar' were planted on Feb. 17. Each cultivar was analyzed separately with 32 plants per treatment in a randomized complete block design with 4 replications. Pinching was performed 27 and 30 days after planting, and the tests were terminated after 95 and 100 days for 'Park Princess' and 'Miramar', respectively. The 5 treatments were (a) all shoots were pinched, (b) only the largest shoots were pinched (only shoots large enough to be pinched at node 3 or 4 and this was about 75% of the shoots), (c) all shoots on single and double uneven plants were pinched, (d) only the largest shoots on single and double uneven plants were pinched, and (e) all shoots unpinched.

For both cultivars, the pinching treatments tended to increase the days to flower, plant height, and number of flowers compared to the unpinched control (Table 5). Generally, as the number of pinched plants in the population decreased from all to only the largest single and double uneven plants there was less of an increase in the measured parameters.

These experiments indicate that for inidivdual plants increased flower number can be obtained through pinching, but increased plant height and delayed flowering also result. These deleterious effects can be minimized by pinching at node 3 or 4 (Tables 1 and 2). The single and double uneven plants normally produce the fewest flowers and would benefit the most from pinching (Tables 1 and 2). Therefore, by pinching only the largest single and double unevens and forcing the other plants unpinched, an increase in flowering of the plants which produce the fewest flowers is obtained with a minimum increase in the average plant height and time to flower for the population (Table 5).

Table 5. Effects of pinching selected plants of 'Park Princess' and 'Miramar'.

Plants pinched	Park Princess: Days to flower	Park Princess: Plant ht (cm)	Park Princess: No. flowers[z]	Miramar: Days to flower	Miramar: Plant ht (cm)	Miramar: No. flowers[z]
All shoots	79.3a[x]	44.0a	3.4a	88.0a	48.3a	2.6a
Largest shoots[y]	78.0a	39.1b	2.0bc	85.5ab	47.7a	3.2a
All singles and double uneven	78.0a	37.3bc	2.9ab	83.8abc	48.7a	2.7a
Largest singles and double uneven	73.3b	34.3cd	2.5abc	82.8bc	45.2ab	2.7a
None	71.5b	31.3d	1.5c	80.5c	41.6b	1.8b

[z]Determined 7 days after opening of first flower.

[y]Largest refers to those shoot large enough to be pinched at node 3 or 4. The other plants were unpinched.

[x]Mean separation within columns by Duncan's multiple range test, 5% level.

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Comparative Floral Fertility in Heat Tolerant and Heat Sensitive Tomatoes[1]

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Additional index words. Lycopersicon esculentum, fruit set, pollen abortion, embryo sac abortion

Abstract. **The heat tolerant tomatoes (*Lycopersicon esculentum* Mill.) breeding line AU 165 and 'Nagcarlang' were compared with the heat sensitive 'Floradel' in fruit set, pollen abortion, and embryo sac abortion. The 2 heat tolerant cultivars had a significantly higher percentage fruit set under both moderate and high temperature in spring and summer than did 'Floradel', but fruit set of all 3 cultivars was significantly lower at high temperature. The fruit set of all 3 cultivars was markedly improved by hand pollination, indicating that insufficient pollination probably was a major cause of heat sterility at high temperature. Both pollen and embryo sac abortion were minor factors in the reduced fruit set observed. Heat tolerance in the cross AU 165 × 'Floradel' appeared to be partially dominant.**

Most tomato cultivars exhibit some heat sterility when grown during the hot humid summers of the southeastern U. S. Yield reductions due to high temperatures have been reported from California (15), the Caribbean tropics (8), the Sudan (1), and even in greenhouses where ventilation was neglected (14). A few cultivars such as 'Porter and 'Saladette' are heat tolerant.

The commonly accepted explanation for tomato heat sterility has been that it was due to pollen abortion at temperatures above 32°C. Schaible (11) reported that the limiting factor in tomato fruit set was a night temperature of 23°. At this temperature, 'Nagcarlang', the small fruited Philippine cultivar which Schaible used to develop heat tolerant tomatoes for the Campbell Soup Company, set a heavy crop of fruit whereas 'Rutgers' was sterile.

The objective of the present study was to determine if differential pollen or ovule abortion could account for the difference between heat sterile and heat tolerant tomatoes and to investigate the mode of inheritance of heat tolerance.

Materials and Methods

Cultivars. Three tomato cultivars were chosen for this study: 1) 'Floradel', a large-fruited Florida-developed fresh market cultivar, 2) 'Nagcarlang', a small round-fruited (2.5 cm diam) Philippine cultivar, and 3) AU 165, a small oval-fruited (2.5 × 3.8 cm) machine-harvest processing-type breeding line developed by Walter H. Greenleaf. AU 165 and 'Nagcarlang' were chosen because they set significantly more fruit than 'Floradel' at the Wiregrass Substation at Headland in south Alabama during the summer of 1973. AU 165 was an F_5 of 'Dwarf Italian' × 'Subarctic Delight'. 'Subarctic Delight' had earlier proven highly heat tolerant at Headland.

Plant production and culture. Seeds were sown directly into 5.7 cm Jiffy Strip peat pots in a steam pasteurized 1 peat: 1 sand medium and thinned to 1 seedling about 10 days after emergence. In 1973, seeds were sown on May 29 and the seedlings transplanted to the field on July 2; the 1974 dates were May 29 and June 28. Field planting dates were chosen for

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