low temperature on canes with fewer than 12 nodes. The present study was designed to establish the effects of low temperatures on flowering of 'Heritage' primocanes.

'Heritage' plants from root cuttings were grown in 20 cm clay pots in a greenhouse with 22-24°C and 16 hr daylength. Selected plants were exposed to low temperature regimes at stages of growth as follows: 1) no temperature below 22° from time of adventitious shoot bud initiation on the root to flowering, 2) exposure in the field until December 5 of initiated shoot buds on roots (such buds contain 4-5 nodes), 3) primocanes at 10-12 nodes of growth exposed to 25 days of 7° and 16 hr photoperiod in a controlled temperature chamber, and 4) primocanes at 14-16 nodes of growth treated as 3 above. The primocanes in the controlled temperature chambers were lighted with a combination of fluorescent and incandescent lights.

Plants grown from adventitious buds without cold treatment flowered terminally and basipetally at 80 nodes of growth. Plants from adventitious buds exposed to low temperature until mid-December flowered at 41 nodes of growth. Primocanes cold treated (7°C) for 25 days at the 10-12 or 14-16 node stage of development flowered at 32 or 28 nodes, respectively. No relationship was found between the number of flowering nodes per primocane and the time of low temperature exposure as all plants produced 12 ± 2 flowering nodes.

'Heritage' primocanes flowered in the absence of any temperatures below 22°C during the life of the cane. Exposure of developing primocanes to temperatures at 7° shortened the vegetative growth phase of the primocanes. The extent of vegetative growth after low temperature exposure was inversely related to the extent of vegetative growth before the low temperature treatment. Low temperatures were not obligatory for floral initiation but influenced the time or growth stage at which floral initiation occurred.

Low temperature, plant age, time of flowering and the termination of the primocane vegetative extension are interrelated. The control of plant development exercised by low temperature may result from a direct influence on floral induction that, in turn, stops vegetative extension (3), stage of plant development being the limiting factor for response. Alternatively, the primocane may have an endogenously controlled seasonal cycle in which flowering is the final phase. Low temperature exposure, at any stage of plant development, shortens the seasonal cycle and earlier flowering results. Because vegetative growth for several nodes follows cold exposure before inflorescences appear we hypothesize that floral induction is not a direct response to cold but rather follows after the impact upon the endogenously controlled cycle. This cycle may be analogous to the juvenility/phase change cycle readily observed in woody plants.

The extent of vegetative growth is determined by low winter temperatures in the field. Encouragement of growth in spring and early summer should advance the fall harvesting season.

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HortScience 15(6):751–752. 1980.

Cellular Variation in Chromosome Number Induced by *p*-Fluorophenylalanine in Grape Seedlings[1]

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Additional index words. Vitis vinifera, haploidy

Abstract. ***p*-Fluorophenylalanine reduced germination and growth of diploid seedlings of grape (*Vitis vinifera* L. cv. Neo Muscat) and induced variation in chromosome numbers from haploidy to tetraploidy including aneuploidy in root cells.**

p-Fluorophenylalanine (PFP) is reported (a) to alter amino acid metabolism (6); (b) to inhibit growth of roots (5) and callus (1); and (c) to induce haploids (2, 3, 4). The original objective of the present study was to induce haploidy grape seedlings.

Seeds of 'Neo Muscat' grape (2n = 38), which were fully stratified in a refrigerator, were germinated at 25°C in vermiculite beds which were moistened with a 160, 80, 40, 20, 10, or 0 ppm PFP solution for the first 10 days and thereafter with tap water. The germination test was replicated 6 times with 10 seeds each time.

Seed germination was observed for 50 days after sowing and shoot and root length was measured. Chromosome numbers were counted in root tip cells according to the following procedures: pretreatment in distilled water at 2°C for 24 hr, fixation with acetic-alcohol (1:3), dissociation in 1N HCl at 60°C for 30 sec, and staining with aceto-orcein. In each tip, more than 10 mitotic figures were observed.

Although PFP did not decrease total germination, it significantly reduced survival 50 days after sowing (Table 1). Though shoot growth was not appreciably affected, root growth was significantly inhibited by PFP. Some root tips became brown after treatment with a high concentration of PFP solution and this reaction appeared to be correlated with the reduction of survival. In these root tips, there were some abnormal mitotic figures in which

[1]Received for publication April 30, 1980. Contribution A-110, Fruit Tree Research Station.

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Table 1. Seed germination, growth, and mitotic abnormalities of grape seedlings treated with PFP at beginning of germination.

PFP concn (ppm)	Seed germination (%)		Avg length, 50 days (cm)		Mitotic abnormalities		
	Total	Survival[z]	Shoot	Root	Total[y] plants examined	No. abnormal plants	No. abnormal cells
0	63	60	31	155	26	0	0
10	73	60	35	164	27	4	4
20	57	48	34	182	22	4	8
40	67	45*	30	112*	21	2	2
80	57	32**	25	83*	10	2	6
160	63	18**	23	12**	5	1	2

[z]Seedlings surviving 50 days after sowing.

[y]Total number of plants in which more than 10 mitotic figures were confirmed in roots.

*,**Significantly different from 0 ppm treatment as 5% (*) and 1% (**) level.

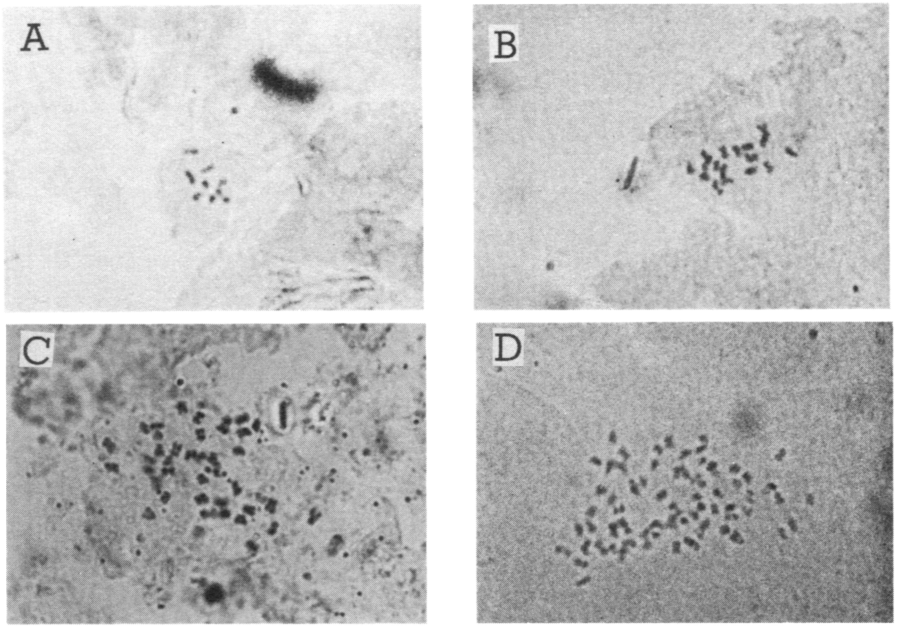

Fig. 1. Mitotic chromosomes in PFP treated root tip cells of grape seedlings from 'Neo Muscat', 2n = 38. A. Aneuploid cell with 9 chromosomes. B. Haploid cell with 19 chromosomes. C. Normal diploid cell with 38 chromosomes. D. Tetraploid cell with 76 chromosomes.

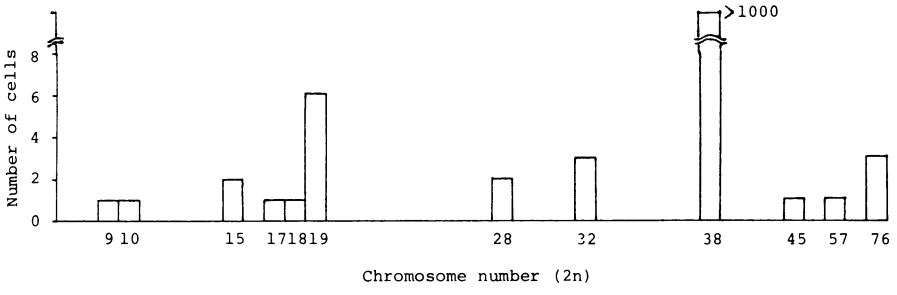

Fig. 2. Variation and frequency of chromosome number in root tip cells of grape seedlings of 'Neo Muscat' (2n = 38) treated with PFP. Normal mitotic figures with 38 chromosomes were counted in more than 1000 cells.

the chromosome number was reduced (Fig. 1). The proportion of roots which contained haploid or aneuploid cells did not show a significant correlation with PFP concentration and ranged from 9.5 to 20.0% (Table 1).

In variant cells of grape seedlings, haploid cells were the most frequent, but the chromosome number ranged from 9 to 76 (Fig. 2). Haploid and aneuploid cells were sometimes observed in the same root. All such cells were observed among normal cells, and their frequency was less than 1% of that of diploid cells.

Although fully haploid grape seedlings were not observed, we have confirmed that PFP induced chromosome variation in root cells including haploidy and aneuploidy.

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HortScience 15(6):752–754. 1980.

Influence of Fertilizer and Lime Rates on Nutrient Concentration in Highbush Blueberry Fruit[1]

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Additional index words. Vaccinium corymbosum, nitrogen, phosphorus, potassium, calcium, magnesium, micronutrients

Abstract. **Concentrations of N, P, K, Ca, Mg, Mn, Fe, Zn and Cu in blueberry fruit (*Vaccinium corymbosum* L. cv. Wolcott) as influenced by 3 rates of N, P, and K and 2 rates of lime were determined for 2-4 years. Concentration varied among years, but the variation was much less for N, P, K, and Ca than for Mg and the micronutrients. Application of N, P, or K increased the concentration of the element applied. Application of lime did not influence elemental concentrations. Increasing N rates decreased fruit Ca, and P decreased Mn concentrations each year.**

The elemental concentrations, especially of cations, in blueberry foliage is usually much lower than those in foliage of other fruit crops (4). Data on the elemental concentration of blueberry fruit are limited and there is unexplained variation among some reported values. This is particularly evident when elemental concentrations of highbush blueberries grown in Michigan (1), North Carolina (2), and Nova Scotia (3) are compared. In general, values for N, P, and K were similar in all reports, but Ca and Mg concentrations varied with geographical location. Bishop et al., (3) observed that as N fertilization increased, concentrations of N and K in the fruit increased, Ca decreased and P and Mg were not affected. Ballinger and Kushman (2) reported a similar effect of N on N and Ca, but also reported that as N supply increased, concentration of P and Mg increased and K decreased. Data regarding Fe, Mg, Zn, and Cu concentrations are sparse (1, 7) while data relative to effects of fertilization on micronutrients are lacking.

A description of treatments, experimental deisgn, field and laboratory procedures and effect of treatments during the years of establishment (6) and on fruit yield and foliar elemental concentrations (5) has been reported. Treatments for 1968-72 (in kg/ha) were N (34, 84, 168), P (0, 25, 50), and K (0, 47, 94) applied annually in factorial combination with 2 lime rates (0 or 2000) applied in 1965. The 100-berry samples taken from the second harvest in 1968, 1969, 1971, and 1972 were

[1]Received for publication July 18, 1980. Paper Number 6420 of the Journal Series, North Carolina Agricultural Research Service, Raleigh, NC 27650.

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