

PAN. Even at this higher dose of PAN, the tolerant 'Coral Magic', exhibited little injury. Foilage not treated with benomyl averaged 14% injury while treated tissue exhibited mean injury levels from 10% to 21%.

Our previous report of the lack of protection of benomyl for PAN injury in pinto bean or 'White Cascade' petunia (10, 11) has been confirmed for 'White Cascade' and 'Coral Magic' petunias in this study. Benomyl significantly enhanced the PAN response in 'White Cascade' petunias at 60-120  $\mu\text{g/g}$  soil.

The threshold for benomyl induced enhancement of the PAN response appears to be 60  $\mu\text{g/g}$  soil. Additional benomyl apparently does not increase susceptibility of the site(s) of action of PAN to any greater extent. The physiological explanation for benomyl enhanced PAN response is subject to speculation. Benomyl has been characterized as an antisenescent agent (18), and PAN injures young immature tissue (17). It is possible that benomyl is maintaining the plant at a stage of optimal sensitivity.

The inability of benomyl to enhance the PAN response in 'Coral Magic' petunia may be related to its inherent tolerance to PAN. It is also possible that when injury severity levels are low, as occurred when 'Coral Magic' was challenged with PAN, differences are more difficult to detect. Experiments in which higher levels of PAN were used, would be necessary to elucidate the response of 'Coral Magic'.

Benomyl can prevent injury from ozone (4, 5, 6, 7, 8, 9, 13) but not from all oxidants. In many polluted at-

mospheres ozone is the major phytotoxic oxidant and hence benomyl would be an appropriate protectant. However, when chemicals are evaluated in the effort to reduce air pollution injury to plants consideration should be given to other atmospheric contaminants.

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## Effect of Inductive Photoperiodic Cycles on Flowering of Kalanchoe Cultivars<sup>1</sup>

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*Abstract.* 'Gelbe Melody', 'Mace', 'Red Mace', 'Rotkappchen', 'Sirius', and 'Solferinopurpur' (*Kalanchoe* x spp.) required a minimum of 14 inductive photoperiodic cycles for normal flowering; 'Feuerwerk II', 'Jupiter', and 'Roterpfeffer' required 21; 'Feuerball', 'Feuerzauber', 'Granta', and 'Korall' required 28; and 'Cherie' required 35.

Kalanchoe cultivars are grown commercially year-round through photo-

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periodic manipulation similar to chrysanthemums, with an extended period of long nights (LN) for flower initiation and development (1, 2). However, these cultivars are a diverse group and vary in their response to number of LN. Pertuit (4) noted enough variation to recommend cultivar-specific schedules, especially in relation to temperature.

Commercial growers have experi-

enced difficulties with transitional flowering, characterized by fewer florets and incomplete development of the florets and inflorescences. In normal flowering, bracts are very small and scale-like, with the inflorescence a dichasial cyme ending in cincinni (3). With incomplete initiation, the inflorescence exhibits less bifurcation and florets, with larger, more developed bracts (phyllody). Under minimum inductive conditions, there may be only 1 bifurcation and 1 floret, with some lateral shoot development (5). This reaction is regulated by the amount of stimulus (i.e., LN cycles) applied (3).

This study was conducted to determine the minimum number of LN needed to induce full flowering of 14 kalanchoe cultivars under greenhouse conditions.

Rooted cuttings were planted February 13, 1976 in 10-cm clay pots, using a 1 pasturized soil:1 peat :1 perlite (by volume) mixture. The plants were grown in a randomized block experiment in a 16.8°C (night), 21 to

Table 1. Effect of number of inductive cycles on days to first open floret of 14 kalanchoe cultivars.

Cultivar	Days to first open floret									Continuous long nights	HSD (1% level)
	0	7	14	No. of inductive cycles (15 hr dark/9 hr light)							
				21	28	35	42	49	56		
Gelbe Melody	--z	--z	75.2	83.2	75.0	73.7	73.5	76.2	75.0	75.7	11.1
Mace	--z	--z	67.5	68.5	68.0	68.7	69.0	73.5	71.3	72.5	3.3
Red Mace	--z	103.7 <sup>x</sup>	65.7	65.2	65.8	67.7	67.7	70.3	70.0	71.5	7.7
Rotkappchen	--z	--z	70.7	69.7	70.0	72.2	73.7	72.5	73.0	73.0	4.3
Sirius	--z	--z	73.3	74.2	74.8	74.2	76.5	79.7	78.0	78.5	5.1
Solferinopurpur	--z	84.7 <sup>x</sup>	77.0	75.5	74.2	76.8	76.0	76.7	78.5	77.7	5.6
Feuerwerk II	--z	--z	86.0 <sup>xz</sup>	74.2	74.7	73.2	74.0	74.8	74.5	72.0	11.8
Jupiter	--z	--z	82.7 <sup>y</sup>	69.0	70.8	71.5	73.0	72.2	73.5	71.5	9.6
Roterpfeffer	--z	--z	92.7 <sup>xy</sup>	77.0	77.3	78.0	78.5	78.0	78.8	75.2	10.6
Feuerball	--z	--z	--z	78.7 <sup>y</sup>	77.0	75.3	76.3	78.7	79.3	76.2	5.9
Feuerzauber	--z	--z	102.0 <sup>xy</sup>	77.8 <sup>y</sup>	75.3	76.2	76.3	76.0	76.5	74.0	8.9
Granat	--z	--z	108.3 <sup>xy</sup>	85.8 <sup>y</sup>	76.5	80.7	79.2	80.8	82.3	78.2	13.6
Korall	--z	--z	--z	80.0 <sup>y</sup>	78.8	77.2	77.5	79.0	79.8	79.7	5.6
Cherie	--z	--z	--z	103.0 <sup>xy</sup>	83.8 <sup>y</sup>	82.0	82.3	83.5	84.5	83.5	9.2

<sup>z</sup>Plants did not flower by termination of experiment.

<sup>y</sup>Transitional florets present.

<sup>x</sup>Non-flowering plants assigned a value of 112 days in this average.

Table 2. Effect of no. of inductive cycles on number of cymes plant of 14 kalanchoe cultivars.

Cultivar	No. cymes									Continuous long nights	HSD (1% level)
	0	7	No. of inductive cycles (15 hr dark/9 hr light)								
			14	21	28	35	42	49	56		
Gelbe Melody	0.0**	0.0**	14.0	18.8	14.0	15.2	17.3	13.8	15.0	15.0	3.8
Mace	0.0**	0.0**	15.5	16.2	18.3	17.0	17.7	15.7	16.5	15.0	3.6
Red Mace	0.0**	4.0**	18.3	16.0	16.7	16.7	19.7	15.7	16.7	16.5	5.5
Rotkappchen	0.0**	0.0**	18.0	14.5	15.7	19.2	19.2	17.2	19.7	14.7	4.0
Sirius	0.0**	0.0**	18.2	17.5	17.7	19.0	21.7	17.8	18.5	18.0	5.0
Solferinopurpur	0.0**	3.5**	12.8	13.5	13.3	17.5	15.3	15.7	17.8	13.7	3.6
Feuerwerk II	0.0**	0.0**	3.0 <sup>zz</sup>	16.3	16.7	18.5	16.8	18.3	17.0	17.3	6.2
Jupiter	0.0**	0.0**	2.8 <sup>zz</sup>	17.5	18.5	19.0	17.8	18.3	19.8	18.3	5.7
Roterpfeffer	0.0**	0.0**	1.2 <sup>z</sup>	12.2	17.3	16.2	17.0	16.3	18.2	16.2	6.3
Feuerball	0.0**	0.0**	0.0**	18.5 <sup>zz</sup>	23.3	24.3	21.7	23.2	25.5	25.7	5.8
Feuerzauber	0.0**	0.0**	0.2 <sup>zz</sup>	12.2 <sup>z</sup>	16.5	19.7	20.3	19.3	19.3	19.8	9.2
Granat	0.0**	0.0**	0.2 <sup>zz</sup>	3.2 <sup>zz</sup>	14.3	17.7	13.7	13.3	13.8	12.5	4.5
Korall	0.0**	0.0**	0.0**	3.8 <sup>**</sup>	15.7	16.2	19.8	16.0	18.0	17.7	6.0
Cherie	0.0**	0.0**	0.0**	3.0 <sup>**</sup>	9.2 <sup>**</sup>	20.2	20.2	19.8	20.2	20.7	5.6

<sup>z</sup>Transitional florets present.

\*\*Significantly different from saturated response (continuous long nights) at 1% level.

24<sup>o</sup> (day) greenhouse, under natural photoperiods. Four-hr night breaks of 100 W/m<sup>2</sup> incandescent light applied in the middle of 15-hr nights produced by black cloth applications were started 2 weeks after planting on these non-pinned plants to produce non-inductive, short nights (SN).

Nine treatments of 0 to 8 weeks of LN, in addition to a continuous LN to flowering were applied, using 6 plants/ per cultivar/ per treatment. Plants were placed under non-inductive (SN) conditions following the inductive treatment.

Plants were tagged daily. Those budded but not flowered by June 5 were assigned a value of 112 days when averaged with flowering plants in transactional treatments in Table 1. Vegetative plants were not included in the analysis of time to first open floret.

Only peduncles originating from the main axis were included in the cyme determinations. Any deviation from the saturated response of a cultivar (i.e., that value determined for the continuous LN treatment) was considered transitional flowering. Normal development of all plants in a treatment was

considered full flowering.

'Gelbe Melody', 'Mace', 'Red Mace', 'Rotkappchen', 'Sirius' and 'Solferinopurpur' were induced fully after 14 LN (Table 1). All plants per cultivar in this treatment developed normal florets based on the number of cymes being not significantly different from the saturated response treatment (Table 2). Twenty-one LN were necessary for full flowering for 'Feuerwerk II', 'Jupiter', and 'Roterpfeffer', while 'Feuerball', 'Feuerzauber', 'Granta', and 'Korall' required 28 LN. 'Cherie' had the longest requirement (35 LN).

The number of cymes initiated along the main floral axis also differed among cultivars. Even when 'Red Mace', 'Solferinopurpur', 'Korall', and 'Cherie' initiated fewer cymes (i.e., not fully induced), all cymes developed fully and contained no transitional florets (Table 2). 'Mace' also followed this pattern in another unpublished study. The remaining cultivars exhibited transitional flowering characterized by bract phylloidy, fewer cymes and florets, and no central cyme.

Under controlled temperature, kalan-

choe plants respond more quickly and uniformly to fewer LN. However, temperature variations can change the number of LN required for 100% flowering (4). A cultivar-specific production schedule would help eliminate some of the problems encountered by commercial growers. During winter months, more economical production would be possible by selecting cultivars that reach anthesis with fewer LN.

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