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Chemical Growth-retardant Height Control of Ornamental Kale

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Ornamental kale *(Brassica oleracea* L.) has become increasingly popular as a fall crop in the midwestern United States because of its long-lasting, colorful foliage. It is an unsuitable summer crop because high temperatures cause excessive stem elongation, which also can occur during fall coloring but is reduced with the application of the plant growth retardant (PGR) butanedioic acid mono(2,2-diethylhydrazide (daminozide) (Bingham, 1991; Luczai, 1992; McAvoy, 1991). However, there is no information available concerning effects of other PGRs on ornamental kale. Our study was conducted to obtain more information on effects of various PGRs on height of fall-cropped ornamental kale.

We sowed 'Coral Prince' and 'Red Kamone' ornamental kale seeds on 9 July 1992 in plug mix (Terra-Lite; Grace-Sierra, Allentown, Pa.) and placed them under mist until they germinated. Plants at the two-true-leaf stage were transplanted into cell packs (5.5 × 5×-6 cm cells) on 18 July. The plants were planted just below the first leaf to equilibrate for initial stem elongation. The root medium contained 1 soil: 2 sphagnum peat: 2 perlite (by volume) amended with (per cubic meter of mix) 890 g Ca $(H_2PO_4)_2$, 593 g KNO_3, 593 g $MgSO_4 \cdot 7H_2O$, 4.75 kg ground limestone, and 74 g Peter's fritted trace elements No. 555 (Peters, Allentown, Pa.). We maintained plants at a night/day cycle of 18/24C by evaporative cooling. Plants at the six-true-leaf stage were transplanted into round 2.2-liter pots (18 cm in diameter) on 12 Aug. On 19 Aug., four PGR treatments (in mg·liter^{-1}) were applied as foliar sprays using a volume of 204 ml·m^{-2}: daminozide at 2500 and 5000; ß–[(4-chlorophenyl)methyl] –α–(1,1-dimethylethyl)-1 *H*- 1,2,4-triazole-1-ethanol(paclobutrazol) at 15; and *(E)*- 1- *(p* -chlorophenyl)-4,4-diemethyl 1-2(1,2,4-triazol-2-yl)-penten-3-ol (uniconazole) at 5, plus a nontreated control. We used a completely randomized desire of five single-plan; replications. Plants were fertilized at each watering from 18 July through 10 Sept. with 200 mg·liter^{-1} each of N and K supplied from 517 mg KNO_3 and 367 mg NH_4NO_3/liter, with 46 mg P/liter supplied from 75% technical-grade phosphoric acid in the irrigation system. After 10 Sept., night temperature was maintained at 15C and N and K were added to irrigation water only once a week. Phosphorus fertilization continued with every irrigation. On 20 Oct., we measured and recorded plant height from the pot rim to the tallest leaf, plant diameter across the widest expanse of leaves, and distance between the pot rim and the lowest foliage. We analyzed data for each cultivar separately using analysis of variance by general linear model procedures (SAS Institute, 1985). Significantly different means were separated by least significant differences at $P \leq 0.05$.

Uniconazole and daminozide at 2500 and 5000 mg·liter^{-1} had the greatest effect on plant height of 'Coral Prince', with a reduction of 16%, 18%, and 26%, respectively, compared to the control (Table 1). These treatments also resulted in plants with a more equal height and width (Fig. 1). Daminozide and uniconazole also reduced the length of the basal stem below the leaves compared to the paclobutrazol-treated or control plants. At the concentration used, paclobutrazol had little effect on reducing plant height and resulted in a more open rosette head. PGRs applied to 'Coral Prince' had no effect on plant diameter.

All PGR treatments reduced 'Red Kamone' plant height by at least 14% compared to the nontreated plants (Table 1). Plant diameter was reduced by the application of daminozide, but top growth also was reduced proportionally (Fig. 1). Paclobutrazol or uniconazole applications decreased plant height but did not affect plant diameter. Although marketable, plants treated with paclobutrazol had an undesirable head because of a more open rosette and looser appearance as a result of increased internode length. The variations in cultivar response to the PGRs that we observed in this study is probably due to differences in vigor and growth characteristics of the two cultivars. 'Coral Prince' is an-upright, vigorous cultivar that grew 26% taller than 'Red Kamone' when no PGR was applied.

Daminozide at 2500 mg·liter^{-1} controlled the height of 'Red Kamone', but caused an undesirable reduction in plant diameter. Luczai (1992) suggested daminozide at 1500-3000 mg·liter^{-1} to achieve height reduction for ornamental kale. Rates of daminozide <2500 mg·liter^{-1} may reduce plant height of both cultivars and may not reduce 'Red Kamone' plant diameter.

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Table 1. Plant growth retardant (PGR) effect on 'Coral Prince' and 'Red Kamone' ornamental kale

PGR	Concn (mg·liter^{-1})	Coral Prince Ht (cm)	Coral Prince Diam (cm)	Coral Prince Basal stem (cm)^z	Red Kamone Ht (cm)	Red Kamone Diam (cm)	Red Kamone Basal stem (cm)^z
None	---	32.0	39.8	11.0	25.3	36.6	4.8
Daminozide	2500	26.3	41.5	7.1	18.5	32.4	4.3
	5000	23.7	39.1	7.5	19.2	33.0	5.0
Paclobutrazol	15	29.4	40.6	9.8	21.1	36.5	5.2
Uniconazole	5	26.8	38.9	7.6	21.7	35.2	5.6
Significance		***	NS	*	**	**	NS
LSD		2.7		1.7	3.6	2.5	

^{z}Stem length from pot rim to first leaf.
^{NS,*,**,***} Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

Fig. 1. Plant growth retardant effect on growth of (top) 'Coral Prince' and (bottom) 'Red Kamone' ornamental kale [left to right (mg·liter^{-1}): nontreated control; daminozide at 2500 and 5000, respectively; paclobutrazol at 15; and uniconazole at 5].

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