

# Paclobutrazol-Soaked Ornamental Kale Seeds Produce Short Seedlings

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## Abstract

Ornamental kale (*Brassica oleracea*) 'Nagoya Red' seeds were soaked in water or four paclobutrazol solutions for 5, 45, and 180 minutes. Treated and non-treated seeds were sown, one seed per cell, in 288 plug trays filled with a soilless plug mix. The percentage of usable plugs and the seedling heights were measured 13 and 20 days after sowing.

To study the long-term effect of paclobutrazol on kale plants, four seedlings per replication per treatment were transplanted 28 days after sowing in 15.3 cm diameter plastic containers using a commercial soilless medium. As long as growth regulator concentrations were not greater than 200 mg L<sup>-1</sup> and times of soaking were not longer than 45 minutes, the percentage of usable transplants was not significantly reduced.

Significant trends in plug height reduction were measured with increasing concentrations of paclobutrazol. This significant trend was not noticeable on mature plants 116 days after planting.

It was also noted that plants from seeds soaked with paclobutrazol at a concentration of 500 mg L<sup>-1</sup> or higher had

thicker, straighter stems. It was speculated that after sowing, the active ingredient diffuses from the seed coats into the growing medium and is then absorbed by the seedling root after germination and emergence.

## Introduction

A common challenge for transplant producers is height control. Many plant growth regulators (PGRs) are applied as foliar sprays or substrate drenches (Barrett and Nell, 1989; Dasoju *et al.*, 1998; Whipker and Hammer, 1997). Soil drenches with growth retardants are often preferred over foliar sprays because of the minimal drift of active ingredient, but paclobutrazol effectiveness may be reduced by growing medium composition (Million *et al.*, 1998).

Application of PGRs directly to seeds may circumvent some of these limitations for bedding plant production. The systemic properties of paclobutrazol and other triazoles (Davis *et al.*, 1988) have been shown to allow the application of growth retardants to seeds with no effect on seed germination (Pasian and Bennett, 2001).

The objective of this study was to compare germination, seedling survival, and seedling height of ornamental kale after soaking the seeds in varying paclobutrazol solutions at three different soaking times.

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## Materials and Methods

Ornamental kale (*Brassica oleracea*)

'Nagoya Red' seeds were soaked in water or paclobutrazol solutions at 0, 50, 200, 500, or 1,000 mg L<sup>-1</sup> for 5, 45, and 180 minutes. Nonsoaked seeds were used as a control. The beaker was agitated constantly during the soaking period. After soaking, seeds were dried for at least 16 hours at 25°C on an open bench.

Treated and nontreated seeds were sown one seed per cell in 288 plug trays (cell depth: 3.1 cm) filled with Sunshine LP5 (Sun Gro Horticulture, Bellevue, Wash.) plug mix. After sowing, seeds were covered with a small portion of the plug medium and placed under an intermittent light mist at 25°C for two to five days.

Plants were then moved to a greenhouse bench (temperature setting 22°C) and irrigated as needed with tap water. Plugs were watered as needed and fertilized with a 20N-8.7P-16.7K liquid fertilizer (Peters Professional<sup>7</sup> water-soluble fertilizer, Scotts-Sierra Horticultural Products Company, Marysville, Ohio) at a rate of 200 mg L<sup>-1</sup> three times a week.

The experiments were conducted in a completely randomized design using 20 seeds per replication with four replications per treatment. Plugs having healthy plants with no deformities and with signs of active growth were considered usable. The percent of usable plugs (the number of plugs : number of seeds sown ratio) and seedling height (the distance from the plug tray and the top of the seedling) were measured 13 and 20 days after sowing. On day 27 only seedling height was measured.

Four seedlings per replication per treatment were transplanted 28 days after sowing in 15.3 cm diameter (1800 ml) plastic containers using a commercial soilless growing medium (Metro-Mix<sup>7</sup>

360, Scotts-Sierra Horticultural Products Company, Marysville, Ohio) containing horticultural vermiculite, Canadian sphagnum peat moss, processed bark ash, and washed sand.

Forty-two days after sowing, height and diameter of the plants were recorded. Plants were measured for final height and diameter 116 days after sowing. After harvesting, plants were placed in a drying oven at 72°C for three days for dry weight determination.

Paclobutrazol rate responses to the PGR, seedling survival, and plant height were determined by regression analysis using the GLM procedure of SAS (SAS Institute, Cary, N.C.). Single degree of freedom contrasts were used to evaluate treatment effects.

## Results and Discussion

Paclobutrazol seed-soaking solutions had a significant effect on the percentage of usable transplants or plugs (Table 1). As long as growth regulator concentrations were not greater than 200 mg L<sup>-1</sup> and times of soaking were not longer than 45 minutes, usable transplant percentages were not significantly reduced below that of the control.

Significant trends in plug height reduction were detected with increasing concentrations of paclobutrazol (Table 2) for all three dates of measurements, indicating that the seedling height of ornamental kale may be controlled by soaking seeds in paclobutrazol.

Forty-two days after sowing, a significant trend of reduced plant height with increasing paclobutrazol concentrations was noticeable (Table 3). This trend was not significant on mature plants 116 days after planting. From a practical point of view, this is important because this

**Table 1. Percent Ornamental Kale ‘Nagoya Red’ Seedling Survival 13 and 20 Days After Sowing From Seeds Soaked for 5, 45, or 180 Minutes in Four Paclobutrazol (Bonzi™) Solutions.**

Treatment (mg L <sup>-1</sup> )	Usable Plugs (%)					
	5 min.		45 min		180 min.	
	13 d	20 d	13 d	20 d	13 d	20 d
0	87.5	85.0	93.8	93.8	91.3	91.3
50	91.3	90.0	85.0	86.3	90.0	91.3
200	91.3	95.0	92.5	95.0	77.5	77.5
500	60.0	65.0	72.5	73.8	58.5	58.5
1,000	55.0	60.0	70.0	71.3	60.0	58.8
<b>Significance</b>						
Linear	**	*	**	**	*	*
Quadratic	NS	NS	NS	NS	NS	NS

NS, \*, and \*\*: nonsignificant, significant and highly significant, respectively.

**Table 2. Ornamental Kale ‘Nagoya Red’ Seedling Height 13, 20, and 27 Days After Sowing From Seeds Soaked for 5, 45, or 180 Minutes in Four Paclobutrazol (Bonzi™) Solutions.**

Treatment (mg L <sup>-1</sup> )	Seedling Height (cm)								
	5 min.			45 min			180 min.		
	13 d	20 d	27 d	13 d	20 d	27 d	13 d	20 d	27 d
0	2.98	3.60	5.40	3.25	3.74	5.70	3.03	3.54	5.41
50	2.26	2.91	4.69	2.00	2.61	4.04	1.78	2.32	3.45
200	2.08	2.71	4.17	2.12	2.63	4.19	1.96	2.51	3.45
500	1.87	2.36	3.59	1.39	1.88	2.89	1.34	1.73	2.67
1,000	1.57	1.95	2.82	1.32	1.81	2.70	1.25	1.54	2.21
<b>Significance</b>	Pr > F								
Linear	**	**	**	**	**	**	**	**	**
Quadratic	NS	NS	NS	*	*	*	*	NS	

NS, \*, and \*\*: Nonsignificant, significant, and highly significant, respectively.

**Table 3. Height of Ornamental Kale 'Nagoya Red' Plants 42 and 116 Days After Sowing From Seeds Soaked for 5, 45, or 180 Minutes in Four Paclobutrazol (Bonzi™) Solutions.**

Treatment mg L <sup>-1</sup>	Time of soaking					
	5 min		45 min		180 min	
	42 d	116 d	42 d	116 d	42 d	116 d
	Plant height (cm)					
0	8.0	23.3	8.5	23.3	8.9	23.3
50	9.1	22.8	7.5	23.0	8.0	23.3
200	8.5	23.8	8.5	24.3	6.9	22.3
500	6.0	22.5	5.6	23.3	5.63	21.8
1,000	5.3	22.0	4.6	21.0	4.2	21.5
<b>Significance</b>						
<b>Linear</b>	**	NS	**	NS	**	NS
<b>Quadratic</b>	*	NS	*	*	NS	NS
NS, *, and **: Nonsignificant, significant, and highly significant, respectively.						

methodology would allow growers to have shorter seedlings and customers to enjoy large garden plants. No significant trends were noticed for plant diameter or dry weight ( data not presented). It was also noted that plants from seeds soaked with paclobutrazol at concentration 500 mg L<sup>-1</sup> or higher had thicker, straighter stems than plants from non-treated seeds or seeds treated at lower concentrations of PGR. At concentrations lower than 500 mg L<sup>-1</sup>, this effect was less noticeable and plants with crooked stems were more noticeable. More work will have to be done to quantify this difference.

The primary mode of action of paclobutrazol is by inhibition of gibberellin biosynthesis (Davis *et al.*, 1988). Based on these results, it is hypothesized that paclobutrazol may adhere to the seed coats rather than diffuse into the seed. It has been shown that tomato, pepper, leek, and onion have a semipermeable layer in the seed coats (Beresniewicz *et al.*, 1995a; 1995b). This layer, located at the innermost layer of the seed coats, has been found to be

permeable to water while inhibiting amino acid leakage or uptake of tetrazolium or lanthanum salts. In the case of seeds treated with paclobutrazol, it is speculated that after sowing, the active ingredient likely diffuses from the seed coats into the growing medium and is then absorbed by the seedling root after germination and emergence.

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