

Flowering attributes of *Henckelia* Royal Queen influenced by pinching and Paclobutrazol application

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Abstract

An experiment was carried out to determine the effect of pinching practice and different concentrations of Paclobutrazol (PBZ) on the flowering of *Henckelia* Royal Queen plants. Completely randomized design with eight treatment combinations of pinching or non-pinching and different concentrations of Paclobutrazol (0, 15, 30 and 60 ppm) soil drench was used with eight replicates for each treatment. Pinching was practiced twice at two weeks intervals. Flowering parameters viz. number of flower buds, days taken to flowering, number of flowers, pedicel length, corolla length and corolla width were measured at two weeks intervals from 9th week after the treatment application. Results disclosed that plants showed better flowering performances ($P < 0.05$) with increasing concentrations of PBZ, but degree of leaf deformation was increased. Therefore, the application of 15 ppm PBZ with pinching showed better to obtain dwarf *Henckelia* Royal Queen plants with improved flowering quality as commercial potted plants.

Received: 21 March 2021

Revised: 11 April 2021

Accepted: 28 June 2021

DOI: <https://doi.org/10.3329/bjsir.v56i3.55965>

Keywords: Flowering; *Henckelia*; Paclobutrazol; Pinching; Soil drench

Introduction

Gesneriaceae is a flowering plant family which comprises of large and colorful plants. The Genus *Henckelia* comes under family Gesneriaceae and its species previously grouped under *Didymocarpus* sect, *Orthoboea* and in the genus *Chirita* (Weber *et al.*, 2011). Parental materials of *Henckelia* Royal Queen (Hybrid of *Henckelia mooni* and *Henckelia angusta*) are classified under genus *Henckelia* (Weber, 2004). *Henckelia* Royal Queen is found in Royal Botanical Garden, Peradeniya, Sri Lanka and morphologically most similar to *Henckelia mooni* plant. *Henckelia* Royal Queen is terrestrial; perennial herb and often shows highly creeping attributes. This creeping nature decreases the potential of *Henckelia* species to introduce to the floriculture market. Generally, this plant is vegetatively propagated through stem cuttings and sexually reproduced through seeds.

Plant growth regulators are highly used in floriculture industry for root initiation, promoting stem growth and also for stimulating flowering and fruiting. Paclobutrazol is one of the widely used plant growth retardants in potted ornamental plant industry to obtain dwarf plants. Paclobutrazol interfere with gibberellin biosynthesis by arresting the oxidation of entkaurene to ent-kauronoic acid through inactivating cytochrome P450-dependent oxygenase (Zhu *et al.*, 2004; Rady and Gaballah, 2012) that resulted inhibited cell elongation. Further, Paclobutrazol shows fungicidal activity due to its activity as a triazole to inhibit sterol biosynthesis (Rathfon, 2005). Paclobutrazol 35mg/AI per pot proves to reduce the plant foliage height and flower stem length, while not changing inflorescence length and delaying the flowering and fruiting of potted Thai Tulip (Pinto *et al.*, 2006).

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In literature survey, pinching practice performs along with PBZ application in potted ornamental plant industry. Pinching defined as “removal of plant terminal growing portion of the stem due to apical dominance” (Ona *et al.*, 2015). The shoot height, shoot diameter and number of flowers increase with the number of pruning (Brum *et al.*, 2007) and increases the days to flowering begins but increases the number of flowers at once (Singh, 2019). Pinching is an important in controlling the flowering time and flower quality. Growth and flowering of crops can be regulated by pinching that increase quality, increase time taken to flowering. Application of pinching practices on *Chrysanthemum* plant showed maximum duration of flowering span, increased length of flower stalk, increased vase life, shelf life and *in situ* longevity of flowers (Jindal *et al.*, 2018). Furthermore, the effect of pinching practice and Paclobutrazol application on flowering characters of Genus *Henckelia* has not been investigated yet. Therefore, the main objective of this experiment was to enhance quality flowering, and to investigate the results of potted *Henckelia* Royal Queen plants through pinching practice and Paclobutrazol soil drench application.

Materials and methods

This experiment was carried out at the 50% shade house, Royal Botanical Garden, Peradeniya, Sri Lanka in 2020. The softwood cuttings of *Henckelia* Royal Queen were collected from parent plant stock, Royal Botanical Garden, Peradeniya. Potting medium was a mixture of sand and compost at 1:1 ratio (Hematharshini and Seran, 2019) which was sterilized by autoclaving and filled the pots (9.0 cm height and 11.0 cm diameter) by leaving 1.0 cm from the top of pots. At the time of planting, the cuttings were treated with IBA (Indole Butyric Acid) and planted to the depth of 2.0-3.0 cm in the center of the pots and placed inside the plant propagators to accelerate the rooting of cuttings. The developed plants were first pinched at 18 weeks after planting according to the treatments (Table I). Thereafter, pinching was carried out two times with two weeks interval.

Paclobutrazol (PBZ) application (single dosage application) was carried out at the 18 weeks after planting but 4 days after first pinching.

The commercial product of Paclobutrazol powder (25% WP) contains 25 g of active ingredient in 100 g of the powder. According to the treatments, required amount of PBZ powder was mixed separately with 1L of water and applied to the plants as soil drench application (30 ml per plant) while for 0 ppm concentration, distilled water was sprayed at morning hour. Other management practices were followed uniformly.

Number of days taken to first flowering (blooming) was calculated from the day of treatment application in each and every treatment separately. Total number of flower buds, total number of flowers, the flower stalk/ pedicel length, corolla width (cm) and corolla length (cm) in each replication in all treatments was counted at 9th, 11th and 13th weeks after the treatment application. Fresh and dry weights of flowers were measured by electric balance at 13 weeks after the treatment application. Dry weight of the plants was taken after oven drying the plants for overnight at 105°C. The data obtained from the experiments were subjected to analysis of variance (ANOVA) using SAS 9.1.3 version. The treatment means were compared using Tukey’s Honestly Significant Difference Test at 5% significant level.

Results and discussion

Number of days taken to first flowering

Table II shows the days taken to first flowering of *Henckelia* Royal Queen plants after application of treatments (18 weeks after planting of the stem cuttings). Pinching alone has not shown the significant difference (P=0.9386) on number of days taken to first flowering. This result was agreed with Singh *et al.*, (2015) who stated pinching has failed to effect on days taken to first flowering in African marigold (*Tagetes*

Table I. Treatments used in this study

Treatments	Paclobutrazol concentration (ppm)			
	0 ppm	15 ppm	30 ppm	60 ppm
Non-pinching (P1)	P1C1	P1C2	P1C3	P1C4
Pinching (P2)	P2C1	P2C2	P2C3	P2C4

Table II. Number of days taken to first flowering and number of flowers per plant of *Henckelia* Royal Queen as influenced by pinching and Paclobutrazol

Treatment		Number of days taken to first flowering	Number of flowers per plant		
Pinching practice	*PBZ solution (ppm)		9 th week	11 th week	13 th week
Non-pinching	0	63.25±2.95	1.38±0.32	0.88±0.23	1.63±0.26
	15	60.88±3.07	1.00±0.38	1.63±0.38	2.00±0.33
	30	59.75±2.19	1.75±0.25	1.88±0.35	2.63±0.26
	60	57.50±1.87	0.75±0.25	2.50±0.33	2.88±0.91
Pinching	0	63.25±6.86	1.13±0.30	1.75±0.31	1.88±0.23
	15	60.13±3.04	1.75±0.41	2.25±0.25	2.75±0.31
	30	59.75±2.47	1.38±0.32	2.13±0.30	2.63±0.50
	60	59.75±2.24	1.38±0.32	1.88±0.50	2.88±0.55
P value	Pinching	0.9386	0.4164	0.2406	0.4568
	PBZ solution	0.0669	0.4756	0.0637	0.1114
	Pinching*PBZ solution	0.0267	0.1965	0.1374	0.8391

Table III. Number of flower buds per plant of *Henckelia* Royal Queen at different weeks as influenced by pinching and Paclobutrazol

Treatment		Average number of flower buds per plant		
Pinching practice	*PBZ solution (ppm)	9 th week	11 th week	13 th week
Non-pinching	0	4.25±1.29	2.75±1.05	2.63±1.13
	15	6.50±1.52	11.38±2.48	13.38±2.32
	30	7.38±1.75	9.88±2.02	15.63±2.56
	60	7.00±2.43	7.38±2.28	10.50±2.06
Pinching	0	4.13±1.43	6.25±1.68	3.63±1.29
	15	10.88±2.29	11.38±1.78	12.38±2.55
	30	3.38±1.19	6.88±1.51	10.50±1.88
	60	2.88±0.88	4.50±0.98	6.88±1.46
P value	Pinching	0.417	0.6414	0.1234
	PBZ solution	0.0473	0.0019	<0.0001
	Pinching*PBZ solution	0.0442	0.2361	0.4234

PBZ: Paclobutrazol powder (25% WP).

Values represent mean ± standard error of eight replicates

erecta). PBZ has not shown significant difference ($P=0.0669$) on number of days taken to flowering according to the data analyzed (Table II). But Abd El-aal and Mohamed (2017) stated that increasing PBZ has increased the numbers of days from planting to start flowering in *Tabernaemontana coronaria* Stapf plant when compared with 0 ppm PBZ treated plants. The obtained results are not in conformity with Wei and Han (1997) and Yewale *et al.*, (1998) on *Chrysanthemum grandiflora* who reported that paclobutrazol at the increasing rate progressively, delayed flowering as the concentration was increased. Moreover Shahin *et al.*, (2006) on *Rudbeckia hirta* and El-Bably (2008) on *Anisacanthus wrightii* found similar results which are disagreed with the present results.

Number of flower buds

The data presented in Table III revealed that number of buds per plant has not shown the significant difference ($P>0.05$) with pinching. Interaction also, was not shown the significant difference with number of flower buds per plant except 9th WAT ($P=0.0442$) that shown significant with number of flower buds per plant. Nain *et al.* (2017) stated that the number of buds per plant increased significantly with

pinching at 5% level of significance and might be due to the reason that extra energy diverted into the production of more reproductive parts instead of vegetative parts. But present results were not agreed with that statement. Seran and Krishanthi (2009) reported that decapitation at an early vegetative growth period effectively increases the number of branches for flower production.

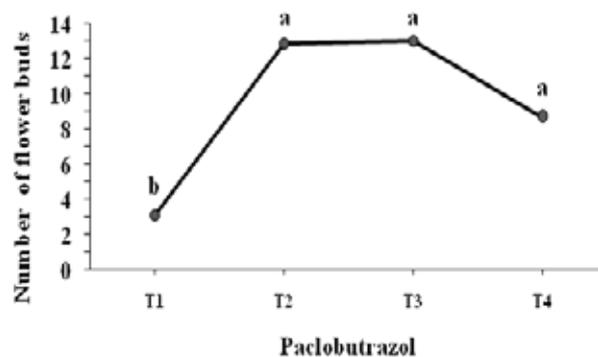


Fig. 1. Influence of Paclobutrazol powder on overall number of flower buds per plant of *Henckelia* Royal Queen plant at 13th week after treatment

Table IV. Length of flower pedicel as well as length and width of corolla of *Henckelia* Royal Queen plant at 13th week after treatment as influenced by pinching and Paclobutrazol

Treatment		Flower pedicel length (cm)	Corolla length (cm)	Corolla width (cm)
Pinching practice	*PBZ solution (ppm)			
Non-pinching	0	4.34±0.10	4.63±0.13	2.64±0.11
	15	3.74±0.14	4.69±0.09	2.31±0.09
	30	2.20±0.17	4.63±0.08	2.38±0.08
	60	1.56±0.18	4.31±0.13	2.31±0.09
Pinching	0	4.56±0.20	5.00±0.16	2.75±0.09
	15	3.11±0.13	4.75±0.13	2.30±0.11
	30	1.81±0.19	4.56±0.22	2.38±0.08
	60	1.60±0.15	4.19±0.09	2.31±0.09
P value	Pinching	0.0996	0.5206	0.7102
	PBZ solution	<0.0001	0.0008	0.0003
	Pinching*PBZ solution	0.0378	0.2759	0.9016

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean ± standard error of eight replicates.

Table V. Weights of single flower of *Henckelia* Royal Queen at 13th week after treatment as influenced by pinching and Paclobutrazol powder

Treatment		Average weight of single flower	
Pinching practice	*PBZ solution (ppm)	Fresh weight	Dry weight
Non-pinching	0	0.21±0.00	0.02±0.00
	15	0.31±0.00	0.03±0.00
	30	0.29±0.00	0.02±0.00
	60	0.25±0.00	0.01±0.00
Pinching	0	0.23±0.00	0.02±0.00
	15	0.27±0.00	0.02±0.00
	30	0.27±0.00	0.02±0.00
	60	0.29±0.00	0.02±0.00
P value	Pinching	0.7534	0.0178
	PBZ solution	<0.0001	0.0976
	Pinching*PBZ solution	<0.0001	0.0006

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean ± standard error of eight replicates

In case of PBZ treatment, it showed significant difference ($P < 0.05$) with number of flower buds per plant and when WAT (week after application of treatments) increased the significant difference also increased correspondently (Table III). The 30 ppm treated plants were shown highest number of flower buds per plant in non-pinching plants at 13th WAT it was obvious that highest number of buds was recorded in 15 ppm PBZ treated and pinched plants. When consider about overall effect of PBZ treatment for number of flower bud formation per plant in *Henckelia* Royal Queen, the 0 ppm PBZ treated plants were recorded significantly low number of flower buds per plant when compared with PBZ treated plants. As a whole, PBZ treated plants has shown higher number of flower buds (Fig. 1).

Number of flowers

All the treatments failed to exert significant effect ($P > 0.05$) on number of flowers per plant as a whole (Table II) in *Henckelia* Royal Queen plants. At 13th WAT, both pinched and non-pinched plants were shown increased number of flowers in PBZ treated plants when compared with PBZ 0 ppm applied plants. But Abd El-aal and Mohamed (2017) mentioned that the increase of number of flowers per plant of *Pelargonium zonale* L. plants is proportional with the

increment of paclobutrazol concentration in the two seasons and interactions between pinching and paclobutrazol concentrations statistically increased the flowers number per plant, hence the highest number of flowers per plant was recorded by pinched plants sprayed with highest PBZ concentration due to the nature of PBZ effects on the prolongation of the vegetative and reproductive growth of *Tabernaemontana coronaria* Stapf plants. Since, increasing the endogenous level of cytokinin by PBZ led to increasing the formation of leaves as well as the number of branches per plant. This effect was reflected on the increase in the formation of the number of flowers per plant. Therefore, present results can be explained as due to the shortening effect of PBZ, even the number of flowers was increased in PBZ treated plants, number of flowers was remained unchanged when compared with non-PBZ treated plants.

Pedicle length

Flower pedicle length or flower stalk length was observed highly significant ($P < 0.0001$) with PBZ treatment applications (Table IV). At the 13th WAT, it was observed that increasing PBZ concentrations have reduced the pedicle length of the *Henckelia* Royal Queen plants. The maximum

pedicel length was recorded in PBZ non-treated (0 ppm) plants while minimum pedicel length was observed in 60 ppm PBZ treated plants. These obtained results were agreed with Mansuroglu *et al.* (2009) who stated that pedicel lengths were linearly decreased with increasing concentrations of paclobutrazol. The overall PBZ effect on *Henckelia* Royal Queen Flower pedicel length was shown in Fig. 2. Pinching has not shown significant difference ($P=0.0996$) with the flower pedicel length while interaction of pinching and PBZ has shown significant difference ($P=0.0378$) on pedicel length.

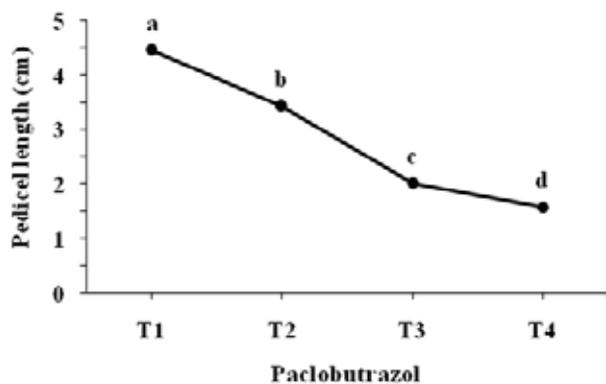


Fig. 2. Influence of pinching and Paclobutrazol powder on overall length of flower pedicel of *Henckelia* Royal Queen plant at 13th week after treatment

Corolla length

Pinching and interaction effect have not shown the significant difference ($P>0.05$) on corolla length of *Henckelia* Royal Queen plants. But the PBZ treatment showed highly significant difference ($P=0.0008$) on flower corolla length. The data obtained at 13th WAT was shown in Table IV. According to the data obtained, results showed the decreasing pattern with increasing concentrations of PBZ. Hence, the maximum corolla length recorded in PBZ non-treated plants while minimum corolla length in 60 ppm PBZ treated plants. The overall effect of PBZ on corolla length (liner reduction of corolla length) has been presented in Fig. 3. These results were agreed with Mansuroglu *et al.* (2009) on *Consolida orientalis*.

Corolla width

The recorded data on corolla width is shown in Table IV. Present results revealed that there was no significant effect ($P=0.7102$) of pinching on flower width of *Henckelia*

Royal Queen plants. The interaction effect between pinching and PBZ concentrations was found non-significant ($P=0.9016$) in influencing corolla width. Even though, PBZ showed highly significant difference ($P=0.0003$) with the corolla width of the *Henckelia* Royal Queen plants. The data shows reduction of corolla width with the increasing concentration of PBZ when maximum corolla width was recorded in PBZ non-treated plants. The gradual descending of corolla width can be explained by reduction of cell elongation with the increasing concentrations of PBZ. But, previous studies on corolla width of *Consolida orientalis* by Mansuroglu *et al.* (2009) stated that corolla width was not influenced by PBZ. In the present study, the overall PBZ effect on corolla width is given in Fig. 4.

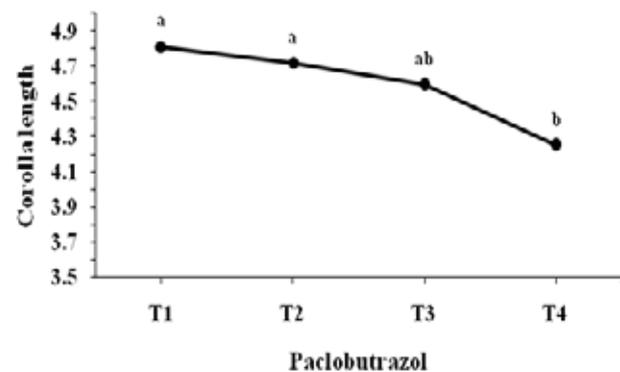


Fig. 3. Influence of pinching and Paclobutrazol powder on overall length of corolla of *Henckelia* Royal Queen plant at 13th week after treatment

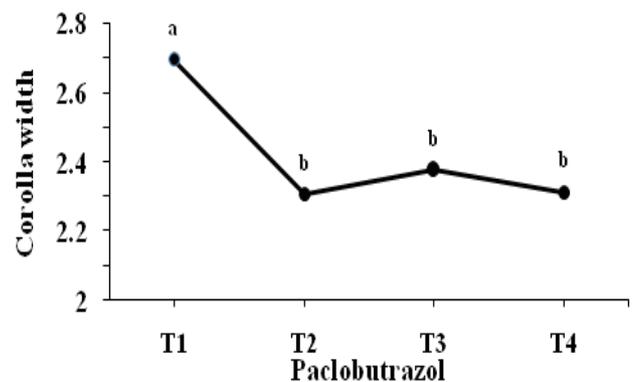


Fig. 4. Influence of pinching and Paclobutrazol powder on overall width of corolla of *Henckelia* Royal Queen plant at 13th week after treatment

Fresh weight of single flower

Fresh weight of single flower of *Henckelia* Royal Queen plant at 13th WAT is given in Table V. There was no significant ($P=0.7534$) effect of pinching on fresh weight of flower. But application of PBZ solution and interaction effect showed that there was significant ($P<0.0001$) effect on fresh weight of flower. Fresh weight of flowers was increased in PBZ treated plants as compared with non-treated plants. Lowest flower weight was recorded in 0 ppm PBZ treated plants at 13th WAT while highest flower weight was reported in 60 ppm PBZ treated plants with pinching. The obtained result of the fresh weight of flowers was coincided with Abd El-aal and Mohamed (2017) on potted Geranium (*Pelargonium zonal*).

Dry weight of single flower

The analyzed results obtained from dry weight data showed significant difference ($P=0.0178$) with pinching (Table V). In case of dry weight of the flowers, PBZ application has not shown any significance difference ($P=0.0976$) on *Henckelia* Royal Queen plants. Hence, the present result disagreed with Sharaf-Eldien *et al.* (2017) in *Zinnia elegans* and Abd El-aal and Mohamed (2017) in *Pelargonium zonal* about the effect of PBZ on dry weight of the flowers on *Henckelia* Royal Queen plants. But, due to the analyzed data, plants showed that there was remarkable difference ($P=0.0006$) due to interaction of pinching and PBZ on dry weight of *Henckelia* Royal Queen plants.

Conclusion

The experiment was carried out to study the effect of pinching practice and different concentrations of Paclobutrazol (PBZ) as a soil drench application on flowering of *Henckelia* Royal Queen plants. It was obvious from the aforementioned results that pinching reduced dry weight of the single flower, while failed to exert any effect on fresh weight of single flower. Most importantly, pinching did not have any effect on any of the flowering parameters measured during the experiment. It was clear from the results of the experiment that increasing concentrations of PBZ (0-60 ppm) obviously decreased fresh weight of single flower, number of flower buds per plant, pedicel length, corolla length and corolla width while did not exert any effect on dry weight of single flower, days taken to flowering and number of flowers per plant. Hence, the experiment has revealed pinching and application of PBZ has the interaction effect or the direct

influence on fresh and dry weight of single flower, number of days taken to flowering, number of flower buds per plant and on pedicel length. It was obvious that, with the increasing concentration of PBZ, length of flowering elements has been reduced and was given smaller flowers that compatible with dwarf *Henckelia* Royal Queen plants. But the increasing concentration of PBZ, simultaneously increased the deformity of leaves. Therefore, 15 ppm PBZ application with pinching practice could be recommended to obtain dwarf *Henckelia* Royal Queen plants with better flowering elements as commercial potted plants.

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