

Optimizing Growth and Morphological attributes of *Henckelia* Royal Queen through Pinching and Paclobutrazol application

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Abstract- The developing floriculture industry seeks domestic pot ornamental plants as it is not further being luxury in effort. Several endemic flowering plants have the potential to introduce as pot ornamental. But creeping growth attributes of this endemic plants should be tested with growth retardants and physical manipulations before introduce those plants into the floriculture market. A shade house factorial experiment was arranged in eight treatment combinations of pinching/non-pinching and various Paclobutrazol concentrations (0 ppm, 15 ppm, 30 ppm and 60 ppm) with eight replicates for each treatment. Paclobutrazol was applied in twice, two weeks intervals while, soil drenching and pinching was done. Results of the experiment disclosed that the plants showed better performances in growth retardation and other characters measured with the pinching and Paclobutrazol concentrations increasing, but degree of leaf deformation was increased when increase the concentration of Paclobutrazol. It was observed that 15 ppm Paclobutrazol applied plants showed balanced growth retardation and acceptable plant characters. Application of Paclobutrazol in concentration of 15 ppm along with pinching caused considerable suppression of height that makes increased floricultural value for the *Henckelia* plants.

Keywords: *paclobutrazol*, *pinching*, *plant height*, *plant growth*, *soil drench*,

I. INTRODUCTION

The *Henckelia* Royal Queen that can be found at the Royal Botanical Garden in Peradeniya is a member of the family Gesneriaceae and is the result of the hybridization of the *Henckelia angusta* and *Henckelia mooni* species. The morphology of the *Henckelia* Royal Queen plant is most similar to that of the *Henckelia mooni* plant. It is a

perennial herb that creeps and can frequently hang down a significant distance from its base. Due to their creeping nature, *Henckelia* species cannot enter the floriculture market. Commercial cultivators frequently make use of growth retardants to accomplish alluring minimal pot-developed plants (Youssef and El-aal, 2017). Paclobutrazol [(2RS, 3RS)-1-(4-chlorophenyl)-4, 4-dimethyl-2-(1H-1, 2, 4-triazol-1-yl)-pentan-3-ol] is the plant growth retardant that is used most frequently in the floriculture industry. It is an inhibitor for the elongation of cells and internodes and also slows plant growth by inhibiting the biosynthesis of gibberellins (Soumya, 2017). According to Starman and Williams (2000), Paclobutrazol is primarily used as a plant growth retardant to control the vegetative growth of a variety of angiosperms.

Paclobutrazol is used to lower the height of plants that are grown in pots, especially ornamental flowering plants (Fletcher et al., 2000). Further, dwarfing method is generally utilized administration practice of cut bloom and pruned decorative plants on the planet to increment branches per plant has ascended in the gardening local area (Burnett, 2017) and to conquer the test of natural feeling of internode extension. In Green gram (Krishnathy and Seran, 2008), pinched plants increase the components of branching, as well as the production of biomass and fruit yield in tomato (Tswanya et al., 2019). When a plant is pinched before the flower buds have fully developed, the result is an inflorescence with a shorter stem that is more appealing (Wien, 2016).

However, no research has yet been conducted on the effects of pinching, Paclobutrazol application, and Paclobutrazol concentrations on Genus *Henckelia* growth. Consequently, this study manages utilization of various concentrations of Paclobutrazol alongside the compacting practice for the viable development of *Henckelia* Royal

Queen Since, the creeping nature of the plant reduce its indoor ornamental value to the great extent.

II. MATERIALS AND METHODS

A shade house experiment was taken place at Royal Botanical Garden, Peradeniya, Sri Lanka from February to October 2020. Softwood stem cuttings (8.0 cm long top cuttings) of *Henckelia* Royal Queen were taken from parent plants raised in Royal Botanical Garden, Peradeniya. Sand and compost (1:1 v/v) were used as a potting medium (Hematharshini and Seran, 2019) which underwent autoclave sterilization. The pots (11.0 cm diameter and 9.0 cm height) were filled with potting medium by leaving 1 cm from the top. The cuttings were treated with Indole Butyric Acid (IBA) prior to planting for the enhance rooting of stem cuttings. Subsequently, they were planted to the depth of 2-3 cm in the center of the pots. After that, they were placed in individual transparent greenhouses made of- polyethylene (20 cm width, 35 cm length and 200 gauges) and were taken 4 weeks to promote rooting of the cuttings.

Mature plants were first picked 18 weeks after planting the cuttings. Thereafter pinched plants were again pinched at 2 weeks intervals for two times. First pinching was practiced 4 days before the application of different concentrations (0/water, 15, 30 and 60 ppm) of Paclobutrazol (PBZ) as soil application (30 ml per plant) at morning hours. The commercial product of Paclobutrazol powder (25% WP) was used in the study here (Business roof Pvt Ltd, Sri Lanka). Watering was done to the cuttings before placing in single propagators and they were not watered until removing the propagators. After removing the propagators, cuttings were regularly watered once in every two days. Hand weeding was practiced to remove weeds present in the containers. At the initial stage of cutting establishment (at the time of planting and 4 weeks after planting), 7.5g/L Mugasole P-52 (Root + Bloom) (Nitro-tech Mugasole, Sri Lanka) soluble foliar fertilizer was sprayed to the plants developed from cuttings using hand sprayer.

Vegetative growth parameters were collected at two weeks intervals after 1st pinching (18 weeks after planting of stem cuttings). Experimental plant height (cm) was measured using the meter scale up to 9th week after treatment application. The height was determined by ground surface from the leaf at the top to the potting medium. The number of lateral shoot buds/branches per plant was count manually in every plant in each treatment from the foundation of the fundamental stem to the tip of the plant after treatment application. Plant stem girth was measured using measuring tape meter scale at once in every three weeks in every plant of each treatment. The mean of first three internodes' length was also taken as measurements of meter scale and average internode length was taken in each replicate in every treatment. A plant's number of leaves, from base of the main stems to the terminal end of the highest leaf, was also manually counted from each

treatment at two weeks intervals. Leaf chlorophyll content was measured at two weeks intervals in every plant of each treatment using SPAD meter. The leaf area meter (Portable leaf area meter AM 350, Netherlands) was used to measure each plant's leaf area in each and every treatment at the end of the 13th week after treatment application. At random, three plants from each treatment (or replicate) were chosen and the length of the longest root was measured using meter scale. Fresh weights of stem, leaves and roots were taken by using electric balance and three sample plants from each treatment (or replicates) were tested for the measurements (at 13th week after treatment application). After 72 hours of Oven drying (at 70°C -80°C), the plant parts' dry weight was measured (Sharma *et al.*, 2012; Rivera-Amado *et al.*, 2019; Mubarak *et al.*, 2022; Mubarak & Mohammathu *et al.*, 2023 and Mubarak & Burgess *et al.*, 2023). Using the portable version of SAS 9.1.3, the data collected from experiments at intervals of one week were subjected to an analysis of variance (ANOVA). Tukey's Honestly Significant Difference Test was used to compare the treatment means at a 5% significance level.

III. RESULTS AND DISCUSSION

A. Plant height

Initial plant heights of the plants were not shown remarkable differences among pinching and PBZ (Table 1) Plant height was significantly varied with pinching and PBZ treatments at different weeks after application of treatments (WAT). The non-pinched plants (P1) had higher plant height gain than pinched plants (P2). The height gain in P1 was gradually increased after the treatment and it was high (13.75 cm) in 0 ppm PBZ while lowest height gain (5.56 cm) was recorded in 60 ppm PBZ at 9th WAT. The lowering of plant height in P2 was observed. It is primarily as a result of apical meristematic tissue, which redirects plant metabolites from vertical to horizontal growth and inhibits apical dominance (Kholiya *et al.*, 2020). This result was agreed with Dorajeerao and Mokashi (2012) who stated that apical bud squeezing causes huge decrease in plant level of numerous ornamental plants.

The plant height of *Henckelia* Royal Queen Plants was greatly ($P < 0.0001$) influenced by treatments of paclobutrazol. The suppression of height was higher in P2 as mentioned previously. Among the PBZ applications (15-60 ppm), the height gain in P1 and P2 was significantly ($P < 0.05$) highest in 15 ppm PBZ and lowest height gain (highest height suppression) was shown by 30-60 ppm PBZ treated plants which exhibited approximately similar suppression of plant height as shown in Figure 1. Plant level concealment by PBZ was accounted for in before concentrates on different plant species (Berova and Zlatev, 2000; Larcher *et al.*, 2011). By preventing the biosynthesis of gibberallic acid, paclobutrazol may have reduced plant height which leads to reduced cell elongation and the results were confirmed with the Singh (2004) in marigold. The interaction results indicated that none of the significant differences in interaction effect of pinching and PBZ on

plant height gain at the 1st WAT ($P=0.36$) and 5th WAT ($P=0.1433$). But at 9th WAT, the significant variation ($P>0.05$) was noted in interaction effect on plant height gain (Table 1).

Table 1: Increase in plant height of *Henckelia* Royal Queen at different weeks after treatment as influenced by pinching and Paclobutrazol

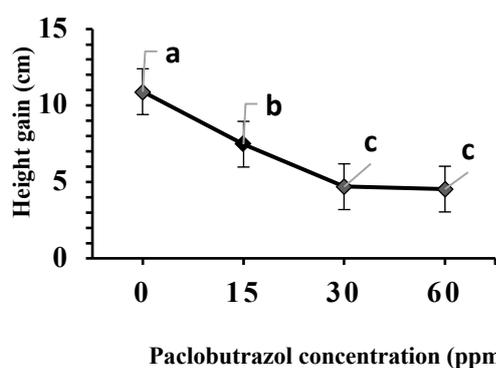
Treatments			Mean height gain at different weeks after application of treatments		
Pinching practice	*PBZ solution (ppm)	#Initial height	1 st week	5 th week	9 th week
Non-pinching	0	12.25±0.73	3.06±0.43	8.69±0.82	13.75±0.92
	15	13.38±1.15	1.69±0.25	5.19±0.61	8.81±0.87
	30	12.69±1.11	1.75±0.19	3.69±0.27	6.25±0.46
	60	14.00±0.61	2.50±0.19	4.13±0.21	5.56±0.20
Pinching	0	12.75±1.11	1.50±0.25	5.06±0.58	8.06±0.98
	15	14.31±1.71	0.94±0.22	3.31±0.23	6.125±0.26
	30	11.38±1.05	0.75±0.21	1.75±0.35	3.12±0.40
	60	11.81±0.79	1.00±0.30	2.50±0.33	3.50±0.28
P value	Pinching	0.1600	<0.0001	<0.0001	<0.0001
	PBZ solution	0.2900	<0.0001	<0.0001	<0.0001
	Pinching*PBZ solution	0.9600	0.3600	0.1433	0.0284

*PBZ: Paclobutrazol powder (25% WP)

Initial height at 18 weeks after planting of stem cuttings

Values represent mean ± standard error of eight replicates

Figure 1: Effect of Paclobutrazol application on overall



increase in plant height of *Henckelia* Royal Queen at 9th week after application of treatments.

B. Number of lateral shoot buds

The results obtained on number of newly developed lateral shoot buds per plant were shown highly significant

differences ($P<0.0001$) due to the pinching practice (Table 2). As per the WAT increase number of lateral shoots was increased. At the 9th WAT, non-pinched plants (P1) exhibited lowest number (17.5) of lateral bud number and highest number (28.63) was shown by pinched plants (P2) in 15 ppm PBZ, Hence, the pinching has increased the number of lateral shoot buds and it is confirmed with Singh *et al.* (2016). But, none of the significant effect ($P>0.05$) reported in number of newly formed lateral shoot buds per plant with the application of increased concentration of PBZ solution as recorded at different weeks after treatment application. The lateral shoot bud number has shown no significant variations with the interaction effect of pinching and PBZ at 1st WAT ($P=0.075$) and 5th WAT ($P=0.0678$). But at 9th WAT ($P=0.0035$) had shown the remarkable difference of new number of lateral shoot buds with pinching and PBZ interaction effect.

Table 2: Number of newly developed lateral shoot buds per plant of *Henckelia* Royal Queen at different weeks after treatments as influenced by pinching and Paclobutrazol

Treatments		Mean Number of new lateral shoot buds per plant at different weeks after treatments		
Pinching practice	*PBZ solution (ppm)	1 st week	5 th week	9 th week
Non-Pinching	0	4.50±0.96	14.00±1.04	19.38±1.21
	15	2.63±0.75	11.50±0.76	17.50±1.61
	30	4.25±1.03	13.25±1.91	18.25±1.28
	60	5.25±0.70	17.50±1.18	24.75±1.37
Pinching	0	8.38±1.41	19.00±1.54	27.63±1.49
	15	10.75±1.21	20.25±1.75	28.63±2.65
	30	10.00±1.32	17.13±1.62	22.13±2.22
	60	7.88±1.09	19.00±1.43	23.13±1.60
P value	Pinching	<0.0001	<0.0001	<0.0001
	PBZ solution	0.9282	0.1407	0.1416
	Pinching*PBZ solution	0.0750	0.0678	0.0035

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean ± standard error of eight replicates

C. Stem girth

Reported no significant effect ($P>0.05$) in stem girth with pinching practice (Table 3). But in 5th WAT ($P=0.0003$) and in 7th WAT ($P=0.0043$), stem girth has been exhibited the significance difference with PBZ. Further, the plants only showed the significant difference in stem girth with interaction effect at 5th WAT ($P=0.0129$) while there were no significant interactions at 3rd WAT ($P=0.1187$) and 7th WAT ($P=0.1567$) as shown in Table 3. According to the overall result of PBZ application on *Henckelia* Royal

Queen Plant species until the 7th WAT, the highest stem girth was measured at 0 ppm PBZ treatment applied plants while increasing PBZ concentrations was resulted reducing stem girth (Figure 2). PBZ solution at 60 ppm recorded lowest stem girth. This outcome was accepted by Xia *et al.* (2018) who stated that during all tested conditions, the stem girth was reduced by applying the PBZ.

Table 3: Influence of pinching and Paclobutrazol on stem girth of *Henckelia* Royal Queen plant at different weeks after treatments.

Treatments		Mean Stem girth (cm) at different weeks after treatments -		
Pinching Practice	*PBZ solution (ppm)	3 rd week	5 th week	7 th week
Non-Pinching	0	0.95±0.03	1.58±0.05	2.60±0.07
	15	0.93±0.03	1.48±0.04	2.50±0.09
	30	0.99±0.03	1.58±0.04	2.54±0.08
	60	1.01±0.03	1.48±0.09	2.41±0.17
Pinching	0	1.03±0.02	1.80±0.10	2.76±0.08
	15	0.98±0.03	1.39±0.03	2.38±0.06
	30	0.95±0.03	1.41±0.05	2.28±0.10
	60	0.98±0.03	1.44±0.04	2.28±0.07
P value	Pinching	0.545	0.7143	0.181

PBZ solution	0.4337	0.0003	0.0043
Pinching*PBZ solution	0.1187	0.0129	0.1567

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean \pm standard error of eight replicates

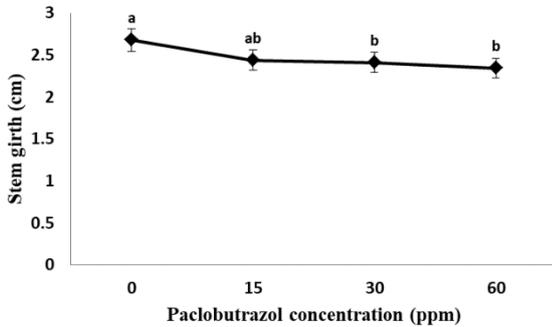


Figure 2: Effect of Paclobutrazol application on overall stem girth of *Henckelia* Royal Queen plant at 7th week after treatments

D. Number of Leaves per plant

In terms of the number of leaves on each plant, the outcome of the experiment concluded that the non-pinched plants (P1) had a greater number of leaves per plant as shown in Table 4. The number of leaves per plant

has shown significant difference ($P < 0.0001$) at 1st WAT due to pinching practice and also remarkable variations were noted even after 1st WAT to 9th WAT. In 60 ppm PBZ, maximum leaf number (32.63) per plant was recorded in P1 while the minimum leaf number per plant (22.00) were recorded in pinched plants (P2) at 9th WAT. Hence, the pinching has decreased the leaf number per plant in *Henckelia* Royal Queen that is disagreed with Thakur *et al.* (2015) in *Barleria cristata* who stated that the Pinching had shown increased number of leaves. The deviation might be due to perennial nature of *Henckelia* Royal Queen species resulted slower growth rate that less lateral shoots results reduced number of leaves. But application of PBZ on total number of leaves/plants has no significant difference ($P > 0.05$) when increasing the concentration of PBZ solution. Even though, the interaction effect of PBZ and pinching on *Henckelia* Royal Queen showed remarkable difference on number of leaves at 9th WAT ($P = 0.0021$) that exhibited significant effect on leaf number per plant.

Table 4: Influence of pinching and Paclobutrazol on number of leaves per plant of *Henckelia* Royal Queen at different weeks after treatments

Treatments		Mean Number of leaves per plant at different weeks after treatments		
Pinching practice	*PBZ solution (ppm)	1 st week	5 th week	9 th week
Non-Pinching	0	10.75 \pm 0.73	23.50 \pm 1.79	31.63 \pm 2.15
	15	9.00 \pm 0.53	19.25 \pm 1.33	26.38 \pm 1.35
	30	10.38 \pm 0.80	24.00 \pm 2.05	32.75 \pm 2.76
	60	9.88 \pm 0.55	22.13 \pm 1.80	32.63 \pm 0.82
Pinching	0	7.63 \pm 0.65	18.63 \pm 1.84	25.63 \pm 1.68
	15	8.25 \pm 0.62	20.63 \pm 1.24	30.25 \pm 1.62
	30	6.38 \pm 0.50	19.00 \pm 1.88	25.75 \pm 2.60
	60	6.63 \pm 0.60	15.63 \pm 0.98	22.00 \pm 0.91
P value	Pinching	<0.0001	0.0022	0.0004
	PBZ solution	0.4605	0.3912	0.7700
	Pinching*PBZ solution	0.0684	0.0940	0.0021

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean \pm standard error of eight replicates.

Table 5: Internode length of *Henckelia* Royal Queen plant as influenced by pinching and Paclobutrazol at different weeks after treatments.

Treatments		Mean internode length (cm) at different weeks after treatments		
Pinching Practice	*PBZ solution (ppm)	1 st week	5 th week	9 th week
Non- Pinching	0	1.94±0.19	2.31±0.20	3.00±0.22
	15	1.60±0.06	2.00±0.77	2.25±0.09
	30	1.11±0.05	1.50±0.09	1.83±0.09
	60	1.60±0.15	1.67±0.18	1.73±0.16
Pinching	0	1.75±0.21	2.35±0.18	3.00±0.27
	15	1.63±0.15	2.27±0.29	2.85±0.34
	30	1.44±0.09	1.65±0.06	1.90±0.06
	60	1.50±0.13	1.54±0.14	1.65±0.13
P value	Pinching	0.8928	0.4475	0.2853
	PBZ solution	0.0023	<0.0001	<0.0001
	Pinching*PBZ solution	0.2965	0.6278	0.2891

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean ± standard error of eight replicates.

E. Internode length

The internode lengths of the plant obtained at different WAT are given in Table 5. According to the data recorded, no any significant differences ($P>0.05$) in internode length with pinching practice and also there was no interaction between pinching and PBZ. But PBZ showed very obvious significant differences even from the beginning of the 1st WAT ($P=0.0023$). Medina *et al.* (2012) was found that, PBZ treatment caused drastic internode length devaluation in *Manihot esculenta*. When the concentration of PBZ increased the reduction of plant internode length was obvious (Figure 3).

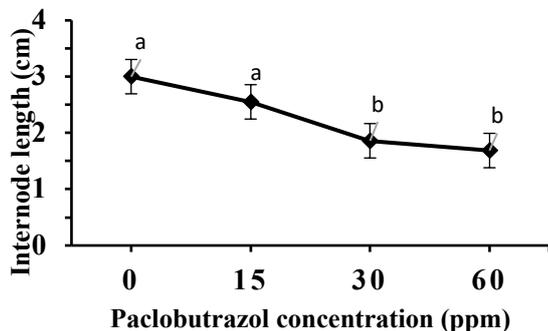


Figure 3: Effect of Paclobutrazol application on overall Internode length of *Henckelia* Royal Queen plant at 9th week after treatments

As an overall at 9th WAT, the 0 ppm PBZ treated plants showed the highest internode length while 60 ppm PBZ treated plants had lowest internode length. This can be explained by mode of action of paclobutrazol, through inhibition of gibberellic acid biosynthesis that causes restricted growth of the internodes as stated by Singh (2004) in marigold.

F. Leaf chlorophyll content

The results obtained in leaf chlorophyll content at different WAT after treatments are given in Table 6. The results at different WAT showed higher P values ($P>0.05$) that confirms no effect of pinching on leaf chlorophyll content in *Henckelia* Royal Queen plants. Meanwhile, interaction effect revealed significant difference in leaf chlorophyll content at 1st WAT ($P=0.008$) and 5th WAT (0.0092) thereafter interaction between pinching and PBZ was not shown at 9th WAT for leaf chlorophyll content. PBZ showed highly significant difference ($P<0.01$) in leaf chlorophyll content at different WAT except 1st WAT ($P=0.2099$). It was obvious that application of PBZ showed the gradual ascending of overall performance of leaf chlorophyll content with the increasing PBZ concentrations at 9th WAT (Figure 4). The recorded SPAD value has shown maximum value at the 9th WAT for 60 ppm PBZ application and minimum SPAD value was recorded for plants which were not treated with PBZ. Leaf greenness could be closely link to photosynthetic performance and this result was accepted by Xia *et al.* (2018).

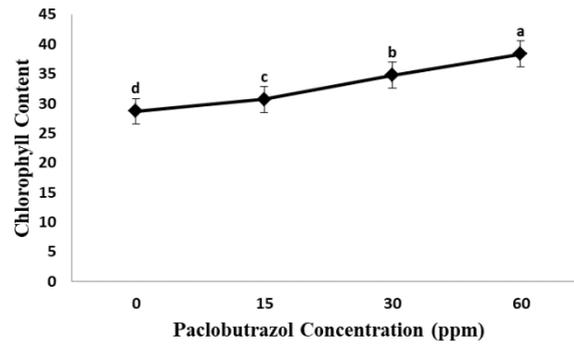


Figure 4: Effect of Paclobutrazol application on overall leaf chlorophyll content of *Henckelia* Royal Queen plant at 9th week after treatments

Table 6: Leaf chlorophyll content of *Henckelia* Royal Queen plant as influenced by pinching and Paclobutrazol

Treatment		Average Leaf chlorophyll content at different weeks		
Pinching practice	*PBZ solution (ppm)	1 st week	5 th week	9 th week
		Non- Pinching	0	22.00±0.52
	15	21.80±1.14	27.65±0.52	31.13±0.56
	30	23.41±0.71	31.24±0.82	35.24±0.29
	60	24.29±0.38	35.69±0.60	38.15±0.76
Pinching	0	21.18±0.89	26.88±0.61	28.46±0.55
	15	24.38±0.65	27.59±0.55	30.18±0.48
	30	22.55±0.99	30.33±0.31	34.29±0.30
	60	21.26±0.72	32.65±0.73	38.54±0.93
P value	Pinching	0.3397	0.0778	0.2442
	PBZ	0.2099	<0.0001	<0.0001
	Pinching* PBZ solution	0.008	0.0092	0.6137

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean ± standard error of eight replicates

G. Leaf area

Results showed the plants shows was no significant effect ($P=0.9979$) in leaf area per plant at 13th WAT due to interaction effect of the treatments of pinching and PBZ (Table 7). In case of pinching, the remarkable difference ($P=0.0002$) in leaf area was noted. Increased amount of leaf area of the tested plants were showed in non-pinched plants (P1) while relatively lower leaf area was showed by pinched plants (P2). The present results were agreed with Sharaf-Eldien *et al.* (2017) who reported that significant reduction in leaf area in *Zinnia elegans* was recorded in pinched plants when compared with non-pinched plants. Mazher *et al.* (2014) stated that boosting the levels of

concentration of PBZ treatments caused gradual expansion of leaf area but present findings did not support that claim. On the other hand, Youssef and El-aal. (2017) showed that increasing concentrations of PBZ significantly reduced the leaf area of *Tabernaemontana coronaria*. It can be confirmed the present results that exhibited the significant difference ($P=0.0282$) in leaf area with the PBZ (Table 7). As an overall view, when PBZ applied to *Henckelia* Royal Queen plants, maximum leaf area was observed at 13th WAT in 15 ppm applied plants and minimum value of leaf area value recorded in 60 ppm applied plants (Figure 5).

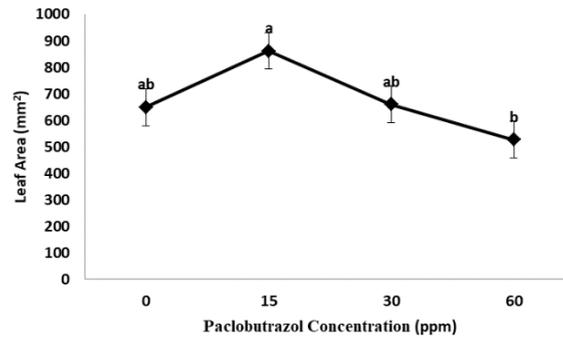


Figure 5: Effect of Paclobutrazol application on overall leaf area of *Henckelia* Royal Queen plant at 13th week after treatments

Table 7: Leaf area and longest root length of *Henckelia* Royal Queen plant at 13th week after treatment as influenced by pinching and Paclobutrazol

Treatment		Mean Leaf area (cm ²)	Mean Length of the longest root (cm)
Pinching Practice	*PBZ solution (ppm)		
Non-pinching	0	823.13±105.06	22.00±0.71
	15	1034.92±50.30	16.67±0.89
	30	828.18±35.99	12.00±1.06
	60	683.62±58.86	9.50±0.77
Pinching	0	474.86±46.93	17.33±0.41
	15	687.41±62.29	15.33±1.34
	30	489.45±51.82	15.33±0.54
	60	369.26±36.97	9.33±1.47
P value	Pinching	0.0002	0.5334
	PBZ solution	0.0282	<0.0001
	Pinching*PBZ solution	0.9979	0.1277

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean ± standard error of eight replicates.

H. Longest root length

Henckelia Royal Queen Species raised from stem cuttings showed no significant results ($P=0.5334$) with the effect of pinching at 13th WAT and also have not shown the considerable variation ($P=0.1277$) in length of the longest root with interaction of pinching and PBZ. But reported highly significant impact ($P<0.0001$) on longest root length with PBZ application. The impact of paclobutrazol on decreasing root length is due to either anti-metabolites or anti-gibberellins hinder root development and function that led to lessened root length (Sharaf-Eldien *et al.*, 2017). Maximum root length was measured in PBZ non-treated plants, Meantime, minimum root length was recorded in 60 ppm Paclobutrazol applied plants (Table 7). Hence, the summarized result of PBZ application to the *Henckelia* Royal Queen plants showed obvious descendent pattern of plant root length with the ascending

concentrations of the PBZ (Figure 6). This outcome perfectly matched with El-Maadaw *et al.*, (2001) in *Begonia*.

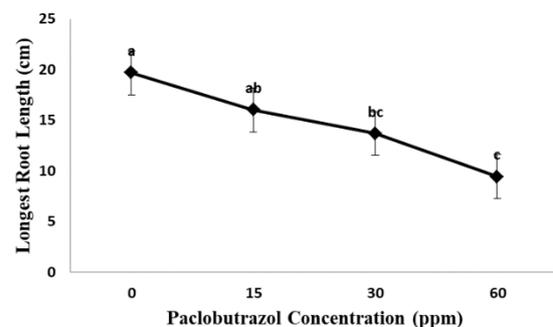


Figure 6: Effect of Paclobutrazol application on overall longest root length of *Henckelia* Royal Queen Plant at 13th week after treatments

Table 8: Dry weights of plant parts of *Henckelia* Royal Queen 13th week after treatment as influenced by pinching and Paclobutrazol powder

Treatment		Average Dry weight (g) of plant parts		
Pinching practice	*PBZ solution (ppm)	Stem	Leaves	Root
Non pinching	0	0.96±0.03	1.73±0.08	0.37±0.01
	15	0.54±.04	1.58±0.02	0.23±.0.02
	30	0.35±0.01	1.49±0.06	0.23±0.01
	60	0.33±0.01	1.17±0.04	0.19±0.01
Pinching	0	0.80±0.01	1.25±0.08	0.33±0.02
	15	0.46±0.05	1.23±0.06	0.19±0.02
	30	0.36±0.02	1.19±0.07	0.18±0.01
	60	0.32±0.01	1.08±0.04	0.16±0.01
P value	Pinching	0.0611	0.0004	0.0215
	PBZ solution	<0.0001	0.0100	<0.0001
	Pinching*PBZ solution	0.2169	0.2566	0.9775

*PBZ: Paclobutrazol powder (25% WP).

Values represent mean ± standard error of eight replicates.

I. Dry weight of stem

Data obtained in dry matter of stem per plant were shown in Table 8 and PBZ treatment showed high significant difference ($P < 0.0001$) in dry matter of stem. Results exhibited descending order of dry weight of stem with the increase of PBZ concentrations. Hence, maximum dry weight of the stem was obtained from 0 ppm PBZ treated plants while minimum dry weight of the stem achieved from 60 ppm PBZ treatment applied plants. These findings were failed to claim with Salem and Mansour (1994) on *Helychrysum bractatum*. But it is agreed by Sharaf-Eldien *et al.* (2017) who stated that increasing PBZ concentrations reduce dry weight which results followed the same order as fresh weight of the stem that can be explained by shortening effect of the PBZ when applied in high concentrations that caused the reduction of dry and fresh weight of the plants correspondently. The pinching effect and interaction effect reported no effect ($P > 0.05$) with fresh weight of the stem.

J. Dry weight of leaves

Dry weight of the leaves/plant recorded at 13th WAT was presented in Table 8. Conforming to the collected data analysis pinching treatment has shown significant impact ($P = 0.0004$) with dry weight of the leaves. Non-pinched plants were shown higher dry weight when compared with pinched plants. This was due to higher fresh weight of the leaves in non-pinched plants that results correspondently higher dry weight of the leaves. This result was confirmed with Shinde *et al.* (2010), the person stated that non-pinched plants were showed maximum dry weight of leaves than pinched plants. PBZ has concluded huge

impact ($P = 0.01$) on dry weight of leaves. Increasing concentrations of PBZ has reduced the leaves' dry weight (Table 8). In plants treated with PBZ at 0 ppm, the maximum dry weight of the leaves was observed; in plants treated with 60 ppm PBZ, the leaves had the lowest dry weight. But this result was disagreed with Mazher (2014) with the PBZ treatment to *Schefflera arboricola* plants. Further, it was observed in the present study that there were no effective difference ($P = 0.2566$) of interaction effect on dry weight of leaves/plant.

K. Dry weight of roots

In case of *Henckelia* Royal Queen Plants, non-pinched plants had higher dry weight of roots/plant than the pinched plants. Highest dry weight of roots was reported at 13th WAT in 0 ppm treated plants. while lowest dry weight of the roots was reported at 13th WAT in 60 ppm PBZ treated plants (Table 8). This result was coincided with Youssef and El-aal (2017) who stated that all tested pinched plants were showed significant difference of roots/plant dry weights as compared with non-pinched plants in *Pelargonium zonal* L. PBZ treatment showed significant reduction effect ($P < 0.0001$) with dry weight of the roots. When concentration of PBZ increased, the dry weight was followed the decreasing order. This can be explained by reduced root length that correspondently reduces the root dry weight due to the gibberellin suppression effect of PBZ (Sharaf-Eldien *et al.*, 2017).

IV. CONCLUSION

The results revealed that pinching reduced plant height, leaf area, number of leaves/plant and dry weight of the leaves, while new lateral shoot buds per plant increased. But pinching has not exerted any impact on internode length, stem girth, leaf chlorophyll content, dry weight of stem and longest root length. In data cleared that rising levels of PBZ (0-60 ppm) resulted visibly decreased stem height, internode length, longest root length, stem girth, plant area of leaf and dry weight of stem, leaves and roots while increasing leaf chlorophyll content and was not effect on leaves number per plant, lateral shoot buds per plant. Hence the experiment has revealed pinching and application of Paclobutrazol treatments has the impacts of interaction or the impacts of each treatment alone on shortening plant height, number of leaves/plant and new lateral shoot buds per plant. Hence, the main purpose of experiment is to obtain undersized *Henckelia* Royal Queen Plants and the Paclobutrazol concentration of 60 ppm has showed maximum suppression of plant height in comparison to PBZ non-treated plants. But, noted that, raising levels of PBZ concentrations had resulted deformed leaves in the plants that gave more compacted plant.

On the other hand, the 15 ppm PBZ applied plants showed no leaves deformation and decreased leaf/plant. Hence, the 15 ppm Paclobutrazol concentration applied plants with pinching had considerable suppression of plant height with improved growth of *Henckelia* Royal Queen plants. Therefore, 15 ppm PBZ application with pinching practice might be suggested to obtain undersized *Henckelia* Royal Queen Plants which avoided creeping nature as commercial potted ornamental plants.

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