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Test of Various PGR and Concentrations to Shoot Cuttings on Chrysant Plant (*Dendranthema grandiflora* T.)

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ABSTRACT

Chrysanthemum (*Dendranthema grandiflora* T.) seedling production in Indonesia is still limited, even still far from the requirement. Chrysanthemum is using shoot cuttings as propagation, it needs hormone to accelerate root growth and improve root quality that will ultimately improve the quality plants and fulfill the demand of this flowers. In this study, young coconut water and cow urine are alternative substitutions of synthetic plant growth regulator. The research was conducted in screenhouse which is using plastic UV as roof, at Sidomulyo, Malang with the altitude 700 meter above sea level. The study was conducted April until June 2009. The research was using Randomized Block Design with three repetitions. Treatment tested in this study were consist of: Without PGR (P_0); Rootone F 1.2 g l^{-1} (P_1); Rootone F 2.4 g l^{-1} (P_2); Rootone F 3.6 g l^{-1} (P_3); young coconut water 375 ml l^{-1} (P_4); young coconut water 250 ml l^{-1} (P_5); young coconut water 125 ml l^{-1} (P_6); cow urine 150 ml l^{-1} (P_7); cow urine 100 ml l^{-1} (P_8); cow urine 50 ml l^{1} (P_9). The result showed that every treatment had percentage 100% of shoot cutting which was having root formation, except treatment of Rootone F 1.2 g l^{-1} (P_1) and without plant growth regulator (P_0) which only got 86.67%. The number of root in treatment young coconut water 125 ml l^{-1} (P_6) 23.17 was not significant different compared with young coconut water 375 ml l^{-1} (P_4). The root length had a high value 2.76 cm by using Rootone F 3.6 g l^{-1} (P_3). Treatment young coconut water 250 ml l^{-1} (P_5) had the high value than the other treatments on variable length of stem, leaf area, number of leaves, flower initiation, and number of flowers.

Keywords: *Dendranthema grandiflora* T., Rootone F, young coconut water, cow urine, shoot cutting.

INTRODUCTION

Chrysanthemums (*Dendranthema grandiflora* T.) is one type of ornamental plants that known and much appreciated by the public with a high economic value. In addition. chrysanthemum can also be used as traditional medicinal plant and botanical pesticide. Therefore, the demand for chrysanthemum is increasing, which in 2006 amounted to 63,716,256 stalks and 2007 was 66,979,260 million stalk (Anonymous. 2008). High demand of chrysanthemums should be followed by the high availability of seeds. However, seed production in Indonesia is still limited and still far from the requirement. The solution to solve this problem is using shoot cuttings as vegetative propagation.

Root emergence is an indication of good cuttings and it needs hormone to accelerate root growth and improvement on root quality that will ultimately improve the quality plants and fulfill the demand of this flowers. Currently, most farmers choose to use synthetic plant growth regulator (PGR) which is in this research were using Rootone F, which is quite expensive and difficult to reach in certain rural areas. Farmers are still using synthetic PGR because there was no alternative to another natural PGR, cheap and easily accessible by farmers. There was not much information regarding the comparison about the use of natural and synthetic PGR to chrysanthemum, so the farmers were not convinced if natural PGR is better than synthetic PGR.

Cow farm waste such as urine can be used as PGR because it contains hormones. Young coconut water also contains some natural hormones. Hormones which is contained in cow urine and young coconut

water is auxin, cytokinins, and gibberellins. Auxin has an important role on rooting formations of shoot cuttings. Analysis auxin concentration as entry point is important to be measured in the cow urine and young coconut water as PGR. It is an effort to produce a natural PGR as an alternative to synthetic PGR on the chrysanthemum.

MATERIAL AND METHODS

The research was conducted in the screenhouse protected with plastic roofing UV in Sidomulyo village, Batu in altitude ± 700 meter above sea level. This research was conducted in April until June 2009. Materials that used for this research consist of shoot cuttings of chrysanthemum variety of Reagents White, husk, cocopeat, Rootone F, young coconut water, cow urine, alcohol 70%, Dithane M-45, Decis 2.5 EC, Rubigan 120 EC, nitrogen phosphate potassium 15:15:15, Growmore, and water.

This study were using randomized block design (RBD) with 10 treatments with 3 repetition. Each treatment consisted of 15 plants. Treatment that were used in this research were consist of: Without PGR (control) (P_0); Rootone F 1.2 g l^{-1} (IBA-NAA 2.04 ppm) (P_1); Rootone F 2.4 g l^{-1} (IBA-NAA 4.08 ppm) (P_2); Rootone F 3.6 g l^{-1} (IBA-NAA 6.12 ppm) (P_3); Young coconut water 375 ml l^{-1} (IAA 1.46 ppm) (P_4); Young coconut water 250 ml l^{-1} (IAA 0.97 ppm) (P_5); Young coconut water 125 ml l^{-1} (IAA 0.49 ppm) (P_6); Cow urine 150 ml l^{-1} (IAA 5.82 ppm) (P_7); Cow urine 100 ml l^{-1} (IAA 3.88 ppm) (P_8); Cow urine 50 ml l^{1} (IAA 1.94 ppm) (P_9).

Observations consisted of destructive and non-destructive. Destructive observations were done at 2 weeks after seedlings and at 2 months after planting. Non-destructive observation were started at 1 week after planting then continued with observation interval once a week.

RESULTS AND DISCUSSION

Percentage of Rooted Cuttings

The emergence of roots is successful indication on vegetative propagation. The number of roots is a representation of shoot cuttings ability to sustain. Based on Table 1, every treatment had percentage 100% of shoot cuttings which were having root formation, except treatment of Rootone F 1.2 g l^{-1} (P_1) and without PGR (P_0) which only got 86.67%. Natural PGR treatments could increase the percentage of rooted cuttings 13.33% compared to without PGR (P_0). Young coconut water contains some hormones such as cytokinin 5.8 mg/L, auxin 0.07 mg/L, gibberellin, and also other compounds that may stimulate germination and growth (Bey, 2006). According to Gardner *et al.,* (1995) which stated that the rapid growth of callus and cell division occur due to the presence of IAA and the purine bases adenine, which is one form of cytokines.

Table 1. Survival root percentages, length and number of root on various PGR treatment

Treatment	Survival root percentages (%)	Length of root (cm)		Number of root	
		2 was	8 wap	2 was	8 wap
Without PGR (P_0)	86.67 a	2.02 ab	11.383	10.03 a	15.50
Rootone F 1.2 g L^{-1} (P_1)	86.67 a	1.70 a	10.683	9.97 a	15.83
Rootone F 2.4 g L^{-1} (P_2)	100 b	2.15 abc	12.167	15.37 b	17.67
Rootone F 3.6 g L^{-1} (P3)	100 b	2.67 c	10.933	18.13 be	20.33
Young coconut water 375 mL L^{-1} (P_4)	100b	2.20 abc	10.400	20.70 cd	20.83
Young coconut water 250 mL L^{-1} (P_5)	100 b	2.03 ab	16.317	18.50 be	21.33
Young coconut water 125 mL L^{-1} (P_6)	100 b	2.27 be	12.017	23.17 d	23.67
Cow urine 150 mL L^{-1} (P_7)	100 b	1.96 ab	10.650	18.83 be	21.00
Cow urine 100 mL L^{-1} (P_8)	100 b	1.80 ab	11.183	15.77 b	19.67
Cow urine 50 mL L^{-1} (P_9)	100 b	2.31 be	10.900	16.27 b	18.33
LSD 5%	10.56	0.55	ns	4.06	ns

Remarks : Numbers followed by the same letter at the same age on the column showed no significant different based on LSD test at level 5%. was: week after seedling. wap: week after planting.

Table 2. Fresh weight and dry weight on various PGR treatment

Treatment	Fresh weight (g plant^{-1})				Dry weight (g plant^{-1})			
	Plant		Root		Plant		Root	
	2 was	8 wap	2 was	8 wap	2 was	8 wap	2 was	8 wap
P_0	0.41 a	5.46	0.004 abc	2.07	0.11	1.04	0.001	0.28
P_1	0.53 be	5.05	0.005 be	1.78	0.14	1.08	0.001	0.26
P_2	0.59 bcd	5.05	0.007 cd	1.69	0.13	1.23	0.002	0.27
P_3	0.59 bcd	6.80	0.009 d	3.07	0.14	1.54	0.003	0.46
P_4	0.66 d	5.95	0.005 be	2.65	0.14	1.39	0.003	0.40
P_5	0.62 cd	6.21	0.004 abc	2.30	0.14	1.19	0.002	0.39
P_6	0.53 be	7.18	0.003 ab	3.26	0.14	1.25	0.003	0.52
P_7	0.52 abc	5.49	0.001 a	2.28	0.13	1.14	0.003	0.37
P_8	0.55 bcd	5.52	0.001 a	2.36	0.14	1.22	0.002	0.39
P_9	0.49ab	5.26	0.006 bcd	1.84	0.12	1.34	0.004	0.37
LSD 5%	0.12	ns	0.003	ns	ns	ns	ns	ns

Remarks : Numbers followed by the same letter at the same age on the column showed no significant different based on LSD test at level 5%; Without PGR (P_0); Rootone F 1.2 g L^{-1} (P_1); Rootone F 2.4 g L^{-1} (P_2); Rootone F 3.6 g L^{-1} (P_3); Coconut water 375 mL L^{-1} (P_4); Coconut water 250 mL L^{-1} (P_5); Coconut water 125 mL L^{-1} (P_6); Cow urine 150 mL L^{-1} (P_7); Cow urine 100 mL L^{-1} (P_8); Cow urine 50 mL L^{-1} (P_9). was: week after seedling. wap: week after planting.

Based on cuttings ability to form roots, The highest number of root were using young coconut water treatment 125 mL L^{-1} (P6) and young coconut water 375 young mL L^{-1} (P4) at 2 weeks after seedling (Table 1). Treatment young coconut water 125 mL L^{-1} (P6) as PGR, increase the number of roots 21.75% more than Rootone F 3.6 g L^{-1} (P3). Based on Table 1, Rootone F 2.4 g L^{-1} (P2), Rootone F 3.6 g L^{-1} (P3), young coconut water 375 mL L^{-1} (P4), young coconut water 125 mL L^{-1} (P6), and cow urine 50 mL L^{-1} (P9) has the same value and longer length of the roots than other treatments at 2 weeks after seedling. Kusumo (1984), suggested IBA that contained in Rootone F usually produce roots that quickly became long because of the energy used for the extension on the roots, there was a significant responds by giving PGR on the number of roots that formed in the shoots cutting. Fauzi (2003), stated treatment young coconut water could increase 25% number of roots that grow from cuttings coffee. According to Dabski (2007), the effect of auxin type IAA on *Hebe canterburiensis* causes higher number of roots, while the length of the root was influenced by auxin type IBA. This is could be interpreted that the difference in the number of roots and root length at transplanting time was not significantly different at 8 weeks after planting.

Based on Table 2, treatment Rootone F 2.4 g L^{-1} (P2), Rootone F 3.6 g L^{-1} (P3), young coconut water 375 mL L^{-1} (P4), young coconut water 250 mL L^{-1} (P5), young coconut water 125 mL L^{-1} (P_6) and cow urine 100 mL L^{-1} (P8) were higher on plant fresh weight than the other treatments. Treatment young coconut water 375 mL L^{-1} (P4) could improve plant fresh weight 10.60% compared to the treatment Rootone F 3.6 g L^{-1} (P3).

Roots fresh weight obtained significant difference between all treatments. Root fresh weight were found higher in the two weeks after seedling by using PGR Rootone F 3.6 g L^{-1} (P3), Rootone F 2.4 g L^{-1} (P2), and cow urine 50 mL L^{-1} (P9). Whereas, there were no significant differences among all the treatments at 8 week after planting. The concentration of young coconut water 125 mL L^{-1} (P_6) to produce fresh weight were no significant different compared to all Rootone F treatment. Different result of fresh weights in the late phase of transplanting had no significant difference when plant at 8 weeks after planting.

Analysis of variance showed that there was no significant effect on the PGR treatment with a particular concentration on the variable total plant dry weight and root dry weight at 2 weeks after seedling and 8 weeks after planting (Table 2). Total plant dry weight is biomass accumulation in a certain time period as the growth process.

Plant growth can be measured by dry weight of plants. PGR treatments were not significantly affect total plant and root dry weight.

Water availability could influences the metabolism of plants and affect the outcome of the dry weight, although young coconut water containing auxin, cytokinins and gibberellins that are able to improve the process of cell division and enlargement. Lack of water could affect the stomata closure, so it could reduce the production of dry weight for the process of photosynthesis decreases (Gardner *et al.,* 1985). This is thought to cause the effect of young coconut water does not appear in the variable plant dry weight and root dry weight.

The Top of The Plant Growth Parameters

The treatment of PGR with specific concentrations of plant growth regulator effect had the highest value after the plant reaches 5 weeks after planting. Young coconut water 250 mL L^{-1} (P5), Rootone F 3.6 g L^{-1} (P3) and cow urine 50 mL L^{-1} (P9) had higher plant height at 5 until 8 weeks after planting than other treatments. Control (without PGR) was not significant different at 6 weeks after planting between treatment Rootone F 2.4 g L^{-1} (P2), and cow urine 50 mL L^{-1} (P9). Whereas, control had plant height lower than other treatments at 7 and 8 weeks after planting

Hopkins (1997), stated that auxin cause the recipient cells on stem secrete H+ to the primary cell wall that surrounds it lowers the pH, then loosening of the cell wall. Low pH was expected activating multiple cell walls of destructive enzymes that were inactive at higher pH. The enzyme is suspected cut off bond of polysaccharides in cell wall, then allowing cell wall to stretch easier. The length of chrysanthemum stem in young coconut water treatment (Table 3) were also due to the presence of cytokines and gibberellin hormone, which contained in young coconut water because gibberellin can stimulate cell elongation that have positive correlation with the length of plant.

Table 3 indicated plant height, number of leaf, and leaf area on various PGR treatment with specific concentration showed significant differences at 8 weeks after planting. Treatment young coconut water 250 mL L^{-1} (P5). Rootone F 2.4 g L^{-1} (P2) and cow urine 100 mL L^{-1} (P8) were having more number of leave than the other treatments. According to Kusumo (1984), IBA hormone that contained in Rootone F have low mobility when compared to hormone IAA on young coconut water. Hormones IBA has unmobile characteristic, that remain in the same place where it given, that it could affect the growth of other parts of the plant, especially on the number of leaves. Leaf area were higher on treatment young coconut water 250 mL L^{-1} (P5) compared to all treatments (Table 3). Young coconut water treatment 250 mL L^{-1} (P5) was no significantly different to the other young coconut water treatments (P4 and P6) and Rootone F 3.6 g L^{-1} (P3) at 6 weeks after planting. Observation at 8 weeks after planting showed if all young coconut water treatment (P3, P4, dan P5), Rootone F 3.6 g L^{-1} (P3) and cow urine 100 mL L^{-1} (P8) were not significantly different of the higher leaf area, it caused by cytokinin and gibberellin on young coconut water that can improve the process of cell division. Auxin is able to liberate the DNA from histones to m-RNA synthesis. Then, m-RNA helps proteins as the composition to build the structure of plants. Cytokinins and gibberellins could accelerate auxins transport (Gardner *et al.,* 1985). Analysis of variance showed that there was no significant effect of all PGR treatment on the stem diameter parameter in whole periods of observations (Table 3), it happened may be due to the cuttings used in this study came from aged mother plant stock, which is lack of meristematic cells so that the diameter stems of plants can not grow optimally (Hartman *et al.,* 1978).

Generative growth of chrysanthemum are marked with the time of flower initiation at 4 weeks after planting. Chrysanthemum flower initiation were significantly affected by exogenous hormones (Table 4). Flower initiation on young coconut water 250 mL L^{-1} were faster 10 days than without PGR (P0). Exogenous hormones addition can increase number of flowers per plant. Young coconut water 375 mL L^{-1} (P5) had better value but not significantly different with all treatments, except treatment Rootone F 1.2 g L^{-1} (P1), that contained IBA and NAA 2.04 ppm and young coconut water 375 mL L^{-1} (P4), that contained IAA 1.46 ppm. Although natural PGR of young coconut water and cow urine

concentration was not high, but it could gave the same result even better than synthetic PGR Rootone F. This is presumably because the content of cytokines in the young coconut water helps generative growth of chrysanthemum.

From the overall treatment. Cow urine had the lowest cost compared to the other PGR treatments and also this material is easily to obtained. However, it still has weakness as a substitute PGR of Rootone F. Young coconut water could be used as substitute to Rootone F, because it has lower cost and better result compared to Rootone F, an also it can accessible in chrysanthemum cultivation area.

If compared with the PGR cost, young coconut water was economical compared to PGR Rootone F. Application of young coconut water 250 mL L^{-1} (P5) can save costs Rp 322 compared to Rootone F 3.6 g L^{-1} (P3) for 60 seedlings of chrysanthemum. Therefore, the application of young coconut water is a wise choice because it has optimum plant performance and cost efficiency of PGR.

Table 3. Plant height, number of leaf, and leaf area of various PGR treatment

Treatment	Plant height (cm plant^{-1})				Number of leaf	Wide of leaf (cm^2 plant^{-1})		
	5 wap	6 wap	7 wap	8 wap	8 wap	6 wap	7 wap	8 wap
P_0	10.70 a	11.77 a	12.16 a	12.72 a	7.33 ab	36.12 a	36.39 a	36.28 a
P_1	12.19 ab	14.53 b	15.78 b	16.98 be	6.89 ab	42.84 abc	42.03 abc	42.53 abc
P_2	12.12 ab	13.98 ab	15.11 b	16.29 b	7.89 be	44.35 abc	42.57 abc	42.75 abc
P_3	13.67 be	15.89 be	17.20 be	18.16 be	7.44 ab	56.78 d	50.82 cd	50.48 cd
P_4	12.16 ab	14.44 b	15.87 b	17.23 be	7.00 ab	48.99 cd	49.28 be	48.74 bcd
P_5	14.86 c	17.48 c	18.63 c	20.08 c	8.78 c	55.72 d	61.46 d	56.13 d
P_6	12.75 abc	14.93 b	16.01 b	17.11 be	7.22 ab	47.74 bcd	46.89 abc	48.28 abed
P_7	12.29 ab	14.70 b	16.26 be	17.73 be	6.44 a	38.03 ab	39.67 ab	37.57 ab
P_8	12.57 ab	14.87 b	15.83 b	17.74 be	7.67 abc	42.78 abc	42.91 abc	44.94 abed
P_9	11.70 ab	13.81 ab	15.34 b	16.61 b	6.56 a	43.20 abc	42.58 abc	40.81 abc
LSD 5%	2.12	2.40	2.49	3.13	1.29	10.8	10.79	12.14

Remarks: Numbers followed by the same letter at the same age on the column showed no significant different based on LSD test at level 5%; Without PGR (P_0); Rootone F 1.2 g L^{-1} (P_1); Rootone F 2.4 g L^{-1} (P_2); Rootone F 3.6 g L^{-1} (P_3); Coconut water 375 mL L^{-1} (P_4); Coconut water 250 mL L^{-1} (P_5); Coconut water 125 mL L^{-1} (P_6); Cow urine 150 mL L^{-1} (P_7); Cow urine 100 mL L^{-1} (P_8); Cow urine 50 mL L^{-1} (P_9). was: week after seedling. wap: week after planting.

Table 4. Time of initiating flower and number of flower on various PGR treatment

Treatment	Initiating flower Periods (dap)	Number of flower per plant (4 wap)
Without PGR (P_0)	38 c	0.67 a
Rootone F 1.2 g L^{-1} (P_1)	36 be	1.22 ab
Rootone F 2.4 g L^{-1} (P_2)	32 abc	1.44 abc
Rootone F 3.6 g L^{-1} (P3)	30 ab	1.78 be
Young coconut water 375 mL L^{-1} (P_4)	30 ab	1.33 ab
Young coconut water 250 mL L^{-1} (P_5)	28 a	2.22 c
Young coconut water 125 mL L^{-1} (P_6)	32 abc	1.89 be
Cow urine 150 mL L^{-1} (P_7)	29 a	1.67 be
Cow urine 100 mL L^{-1} (P_8)	28 a	1.89 be
Cow urine 50 mL L^{-1} (P_9)	32 abc	1.33 ab
LSD 5%	6.65	0.78

Remarks : Numbers followed by the same letter at the same age on the column showed no significant different based on LSD test at level 5%; dap:day after planting. wap: week after planting.

CONCLUSION

Young coconut water treatment 250 mL L^{-1} (P5) could be used as an alternative PGR substitute of Rootone F because it can provide rooted cuttings percentage 100% same with Rootone F 2.4 g L^{-1} and 3.6 g L^{-1}. Treatment of young coconut water 375 mL L^{-1} (P4) contained IAA 1.46 ppm could increase number of roots 21.75% higher than Rootone F 3.6 g L^{-1}. While young coconut water 250 mL L^{-1} (IAA 0.97 ppm) could increase plant height 2 cm, leaf area 6 cm^2, and 2 number of flower higher than Rootone F 3.6 g L^{-1} as PGR treatment

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