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Paclobutrazol Application and Shading Levels Effect to the Growth and Quality of Begonia (*Begonia rex-cultorum*) Cultivar Marmaduke

Yayat Rochayat Suradinata., Ramadhani Rahman., Jajang S. Hamdani
Agrotechnology Department, Faculty of Agriculture Universitas Padjadjaran, Jl. Raya Bandung-Sumedang, km 21 Jatinangor 40600, Indonesia

Abstract

Belonging to one of begonia leaf plants is *Begonia rex cultorum*, this group belong to the class of rex begonians. An ornamental plant species are known for the leaf colour and pattern. The objective of research to study growth and quality of *Begonia rex-cultorum* 'Marmaduke' caused by application of paclobutrazol and shading levels. This experiment was arranged in Split Plot Design consisted of two factors with shading as main plot and paclobutrazol concentration as subplot. The mainplot consisted of three levels, ie., light shading; moderate shading; and heavy shading. The second factor was concentrations of paclobutrazol application consisted of four levels, i.e., without paclobutrazol, 1 ppm paclobutrazol, 2 ppm paclobutrazol and 3 ppm paclobutrazol. The experiment consisted of 12 treatments units with three replications. The result of this experiment showed that there was significant interaction between levels of shading and paclobutrazol concentrations on average leaf area. Application of 3 ppm paclobutrazol with heavy shading gave the lowest average leaf area, whereas non paclobutrazol treatment with heavy shading gave highest average leaf area on 12 weeks after treatment. Treatment of light shading decreased specific leaf area compared with heavy shading. However treatment of 3 ppm paclobutrazol decreased plant height, plant canopy diameter, petiole length, petiole diameter, and specific leaf area, but it increased number of bud tips and number of leaves compared without application of paclobutrazol. Treatment of paclobutrazol (1 ppm, 2 ppm and 3 ppm) on all of shading levels (light, moderate, and heavy) gave higher consumers preference of shoot structure and leaf color compared with non treatment of paclobutrazol on all of shading levels.

Keywords: Begonia, Paclobutrazol, Shading

Introduction

Begonia rex-cultorum ornamental plant is one of begonia groups that has the beauty of leaves, patterns and color varieties (Thompson & Thompson, 1981). One interesting cultivar of *Begonia rex-cultorum* is 'Marmaduke'. Its growth is fairly fast but it is less attractive and compact, it can be seen from the long petiole size and fewer bud tips. These problems are expected to be resolved by application of plant growth regulators which are inhibiting (retardant).

One of the growth regulators that can be used is paclobutrazol, it is a growth inhibitor material that works on sub meristems by inhibiting the biosynthesis of gibberellins through inhibition of oxidation kauren be kaurenic acid thus inhibiting cell elongation and enlargement (Cremlyn, 1991; Mahgoub *et al*., 2006; Wang *et al*., 1986). Paclobutrazol PGR application on ornamental plants will give growth responses in compact, robust, increasing green leaf plants, therefore the

Corresponding author's details:
Name: Yayat Rochayat Suradinata
Email address: *dryayat_effendi@yahoo.com*

ornamental plants performance becomes more attractive, strengthen the flower stalk, and increases the leaves resistance to environmental stress (Mansuroglu *et al.*, 2009). Beside that paclobutrazol application in the nursery can prevent hasty repotting, and reduces water and fertilizer use that will streamline labor and cost production, it also reduces pollution to environment (Conover, 1994; Poole & Conover, 1992). But the most important for potted plants, the use of paclobutrazol can improve quality and selling value (Milandri *et al*., 2008).

The use of paclobutrazol is able to cover the shortage of bad consequences from low intensity of sunlight received by plants. On lower light intensity, paclobutrazol application is needed to suppress the etiolation adverse effects due to the increase of gibberellins synthesis.

In the study of *Lantana camara* L.subsp. *camara* ornamental plant, there was interaction between shading level and paclobutrazol concentration. Growth index increased while the number of flowers per plant decreased in every increasing shading level 0% to 65% at all paclobutrazol concentration tested levels (0, 20, 40, 80 and 160 ppm) (Matsoukis *et al*., 2001).

The presence of interaction between paclobutrazol concentration application and various levels of shading indicates that the use of paclobutrazol can essentially improve the shortage due to the influence of shading, otherwise the use on certain concentration paclobutrazol will show better growth and quality preferred by consumers when using a particular shading level than other levels.

The information about the use paclobutrazol on ornamental plants especially in *Begonia rex-cultorum* 'Marmaduke' is limited, thus it is necessary to do a research on the application of paclobutrazol under different shading in order to acquire ornamental plants with better growth and quality, also preferred more by consumers.

The objective of research is to get an information about begonia plants which have good growth and qualities and also preferred by consumers.

Materials and Method

The experiment was conducted in greenhouse at Agriculture Faculty, Universitas Padjadjaran Jatinangor, with altitude $\pm$ 740 m above sea level. The experiment was carried out from March until June 2011. The materials used in this experiment were seedlings of *Begonia rex-cultorum* 'Marmaduke' 5-month-old from leaf cutting, media mix of burned husk and humus with ratio of 1:1, NPK plus fertilizer 18:9:10, NPK leaf fertilizer 30:10:10. Pesticides used were Deltametrin 25g/L, and Mankozeb 80%. While the PGR used was an instant paclobutrazol (Patrol) 100 ml with the active ingredients paclobutrazol 250 g / L and the solvent is distilled water. Plastic pots (ϕ 15 cm), and shading paranet 45% and paranet 75%.

The experiment was arranged in Split Plot Design, with two factors: shading levels as the main plots consisted of three levels namely: n_1: light shading (greenhouse shading) with 34.15 in Watt/m^2 light intensity, n_2: moderate shading (greenhouse shading + paranett 45%) with 14.96 Watt/m^2 light intensity, and n_3: heavy shading (greenhouse shading + paranet 75%) with 6.82 Watt/m^2 light intensity, the second factor was paclobutrazol treatment which was used as a subplot consisted of four concentrations namely: p_0 = 0 ppm, p_1 = 1 ppm, p_2 = 2 ppm and p_3 = 3 ppm.

Plants that had already had two to four leaves and same height were selected as many as 432 plants. Planting media preparation included sterilization by steaming for about one hour. After sterilizing the planting media, then did the mixing between husk and humus with ratio of 1:1 (v / v). Planting media was inserted into the pot about a half of the pot, prepared seedlings were planted into the media, then added more media up to neck pot limit or stem base.

Paclobutrazol watering was done one-time, which was applied at the age of 1 week after planting. It was carried out in the morning by drench evenly over the media surface with volume of 100 mL/ plant with appropriate concentrations of the treatment.

Plants maintenance included watering, it was carried two to three days once in the morning as much as 200 mL/ pot. Fertilization was done every two weeks used NPK fertilizer with concentration 1 g/L water and NPK 18:9:10 as much as 3 grams per pot mixed with planting media, pest prevention and control were done by spraying a contact insecticide Deltametrin 25g/L, fungi was controlled using systemic fungicides Mankozeb 80%.

Supporting parameters observed included electrical conductivity, plant water requirement, and environmental conditions during the experiment. The main parameter observed included plant height, number of leaves, canopy diameter, average petiole length, bud emerging age, average leaf area, number of buds, petiole diameter, and Specific Leaf Area, and plant quality including leaf color measurement and consumer acceptance. Data analysis based on Duncan Multiple Test Distance and Friedman Test at 5% level.

Results and Discussion

Laboratory analysis results showed that the application of paclobutrazol did not affect the initial pH of planting media, but at the end of the observation of there was an increase in pH close to neutral pH, it's because of planting media leaching caused by watering, this led to a decrease of organic acids in media due to leaching by watering.

Acidity tolerance range of planting media for begonia by Tebbitt (2005) ranged from 5.5 to 7.0 therefore at the range, the begonia can still grow well, although at a slightly acidic media. Measurement of electrical conductivity (EC) showed that total amount of dissolved nutrient solution in planting media, the higher the EC, the higher the content of dissolved nutrients in the media, but it did not indicate the proportion of certain type of nutrients. At the end of the study (12 WAT) there was an increase of EC compared to the initial EC (1 WAT) meant that the slow release fertilizer used had experienced a lot of dilution so that EC had greater value at the end of experiment.

Range from 0.3 - 0.6 mS / cm for initial observations and from 0.7 - 2.02 mS / cm for the final observation in accordance to Handreck & Black (1986) for very sensitive plants to salinity such as Begonia, EC value range of media should not be more than 1.8 mS / cm.

Observation of water requirement of plants showed that increasing levels of shading would decreased plants water requirement. It is related with low level of evapotranspiration, on the heavy shading generally the humidity tended to be high so that the water content in plants was not rapidly lost from the plants also from planting media through evapo-trans-piration. Whereas with the increasing concentrations of paclobutrazol causing smaller leaf size and shorter stem, so the plants water requirement would be less.

Research result conducted by Poole & Conover (1992) showed that *Dieffenbachia* 'Camille' and 'China Doll' plants which were given paclobutrazol, just required little water.

Measurement result of average intensity of sunlight in the greenhouse under light, moderate and heavy shading, respectively at 23.33, 10.24 and 4.67 Klux (6.82 Watt/m^2). On the light shading, the light intensity was still sufficient for begonia need, according to Dole and Wilkins (2005) stated the need of light intensity for *Begonia rex* ranged of 2000 fc-2500 fc (31.50 to 39.37 Watt/m^2). According to the result of measurement with increasing shading levels, the light intensity and temperature were decreased in contrast to increasing humidity. This is in line with what was said by Prasetyo *et al*. (2006) that the higher level of shading, the lower air temperature and light under the shading, however the humidity is increased.

Result of Gibberellins content analysis tended to decline, in line with the increasing application paclobutrazol in the same shading level. Paclobutrazol treatments (1 ppm, 2 ppm and 3 ppm) contained higher gibberellins than without paclobutrazol (0 ppm) at each level of shading, the heavier shading levels, the more trend of gibberellins hormone content for every same paclobutrazol level.

The content of chlorophyll in the leaves indicated that due to the increase of shading chlorophyll a, ratio a/b, total tended to decrease,

while chlorophyll b increased. Whereas with the increasing of paclobutrazol concentrations chlorophyll a, b, ratio a / b, total tended to decrease.

Ratio a/b turned to be down due to increasing level of shading, according Sopandie *et al*. (2003) shading causes a light increase of chlorophyll a, while chlorophyll b rises sharply led to a decline of chlorophyll a/b ratio, especially on sensitive rice genotypes.

Besides a decline in total chlorophyll at each paclobutrazol concentration increase, allegedly is caused by the greater formation of carotenoid pigments than the chlorophyll. According to Mahoney *et al*. (1998) paclobutrazol applications on plant can increase the carotene content of black spruce.

There was no interaction between shading level and paklobutrzol concentration on plant height, number of leaves, canopy diameter, average petiole length and age of bud emerging. Shading level independently did not affect on plant height, number of leaves, and average petiole length, unless on plant canopy diameter (Gardner *et al*., 1991).

On the longer and thinner petiole (etiolation) mainly on the mature leaves resulting a lack of petiole to support the weight of leaves which is getting broad, it causes the leaves tend to grow more horizontal so that the diameter of the plant will increase.

Paclobutrazol independent effect on 3 ppm paclobutrazol treatment was significantly different than without paclobutrazol on plant height, number of leaves, canopy diameter, average petiole length, and age of bud emerging at 12 weeks after treatment. The higher the concentration paclobutrazol, the lower the parameters value mentioned. This is assumed due paclobutrazol inhibits division and enlargement of plant cells. According to Latimer (2009) the use of retardants as well as paclobutrazol can reduce plant height by inhibiting the production of gibberellins, as the hormone that plays an important role for cell enlargement and elongation. According to Chaney (2004) when gibberellins production is inhibited, cell division still occurs, but the enlargement and elongation of new cells will be inhibited.

Average leaf area (Table 1) shows the interaction between shading levels and paclobutrazol concentrations on 12 weeks after treatment. Application of 3 ppm paclobutrazol had the smallest average leaf area and significantly different with 0 ppm, 1 ppm and 2 ppm paclobutrazol at heavy shading level, also significantly different with 3 ppm paclobutrazol in light shading, but not with 3 ppm paclobutrazol at moderate shading level.

Plants without paclobutrazol application (0 ppm) had larger average leaf area because gibberellins hormone synthesis in plants was not inhibited so that cell division and enlargement periclinally in plants could take place.

The greater concentration paclobutrazol will suppress the biosynthesis of gibberellins hormone, resulting smaller leaf area. Matsoukis *et al*. (2001) reported that increasing concentrations of paclobutrazol and triapenthenol generally led a vast reduction in leaf area of *Lantana camara* on different shading levels. While the results of Masyhudi research (1999) suggested on jasmine that the higher the concentration of paclobutrazol, the smaller the leaf area.

Table 1: Observation result of the influence of shading levels and paclobutrazol concentrations on average of leaf area (cm^2) *Begonia rex-cultorum* 'Marmaduke' at 12 WAT

Shading levels	Paclobutrazol concentrations (ppm)			
	p_0 (0 ppm)	p_1 (1 ppm)	p_2 (2 ppm)	p_3 (3 ppm)
n_1 (Light)	68,05 a A	52,01 a B	48,66 a B	45,56 a B
n_2 (Moderate)	73,88 a A	69,17 a A	71,62 b A	31,13 ab B

n_3 (Heavy)	82,58 a A	54,30 a B	43,26 a B	25,39 b C

Note: The average values followed by a same letter are not significantly different according to Duncan Multiple Distance Test at 5% level.
Lowercase letters indicate the average comparison in vertical while the upper indicates the average comparison in horizontal.

Applications of high paclobutrazol concentrations in plants will greatly reduce the overall growth of the plant including leaf area. At low light intensity, plant growth tends to be slower because of lesser assimilate. This caused pressure , resulting slender plant with smaller leaf area and thinner leaves.

In Table 2, there is no interaction between shading levels and paklobutrzol concentration on parameter number of shoots, petiole diameter, and specific leaf area at 12 weeks after treatment. Independent effect could be shown in the number of shoots and petiole diameter, while it showed no significant difference between these two parameters, only Specific Leaf Area that showed the enhance at each increasing shading level.

In addition, if the shading was increasing SLA value would be greater, it could be seen in SLA heavy shading value of 554.55$cm^2.g^{-1}$ while moderate and light shading respectively at 506.23 $cm^2.g^{-1}$ and 466.06 $cm^2.g^{-1}$.

The greater SLA value in low light intensity due to heavy shading can cause greater growth of leaf area, while the lower photosintate accumulation due to shading by the leaves itself also because of the heavy shading, therefore available light for photosynthesis is less, consequently photosintate formed is minimal The effort made by the plant in expanding its leaves is a shading avoidance mechanism in order to maximize the low exposure. This is the strategy of plant in facing environmental circumstances that may be intended to intercepting more light on low radiation quanta condition. At high radiation quanta, narrow but thick leaves are possibly to reduce the light absorption and transpiration (Sitompul and Guritno, 1995).

Paclobutrazol applications independently can increase the number of buds due to amount of cytokinin formed and allocation of photosintate utilization. The relationship of cytokinin on the formation of lateral buds is reinforced by the opinion of Gardner *et al*. (1991) that the transport of cytokinin from the roots will stimulate growth in axillary buds, further explained by the exogenous application of cytokinin stimulate the growth of lateral buds because the buds are generally lack of cytokinin. The result of Syahid (2007) regarding the application of paclobutrazol on in vitro culture of ginger (*Curcuma xanthorrhiza*) indicated that the formation of new buds continued to raise until the seven-month-old, although in small amounts, presumably because of endogenous cytokinin content in the tissue is high enough, thus at the certain treatment level the new buds are still formed.

Table 2: Observation result of the influence of shading levels and paclobutrazol concentrations on number of buds, petiole diameter and Specific Leaf Area *Begonia rex* ''Marmaduke'

Treatments	Observation		
	Number of buds	Petiole diameter (cm)	Specific Leaf Area ($cm^2.g^{-1}$)
Shading levels			
n_1 (Light)	2,2 a	5,4 a	466,0 b
n_2 (Moderate)	2,0 a	4,9 a	506,2 ab
n_3 (Heavy)	1,8 a	4,7 a	554,5 a
Paclobutrazol concentrations			

p_0 (0 ppm)	1,5 b	5,8 a	534,4 a
p_1 (1 ppm)	1,7 b	4,8 b	518,3 a
p_2 (2 ppm)	2,3 a	4,8 b	510,6 ab
p_3 (3 ppm)	2,5 a	4,6 b	472,3 b

Note: The average values followed by a same letter are not significantly different according to Duncan Multiple Distance Test at 5% level.

Paclobutrazol application will inhibit the petiole diameter enlargement, because paclobutrazol inhibits gibberellins formation required by petiole cells to segregate and enlarge, therefore the petiole growth is hampered. This thing is not occurred in plants that are not given paclobutrazol, the plants have greater petiole diameter because the plants grow normally.

In addition, there was a relationship between petiole diameter and number of buds, the more number of buds on paclobutrazol treatment at concentration of 2 ppm and 3 ppm , the smaller petiole because photosintat division in lots formed buds. Plants that were not given paclobutrazol with fewer number of buds will accumulate photosintat for further leaf growth, the growth generate larger petiole diameter.

While, the measurement of Specific Leaf Area (SLA), from analysis perceptible SLA of concentration application of 3 ppm paclobutrazol had higher value than without paclobutrazol application. It can be said that the use of paclobutrazol can strengthen a plant leaf. As research on tomato plants, application of paclobutrazol was found to increase the enlargement of palisade tissue cells in the tomato leaf mesophyll of 32.6% and 41.6% (Tekalign, 2005 cited by Nazarudin *et al*., 2007).

Plant quality, color units L*a*b* Leaf (CIELAB)

The more positive the value of a* so the color will tend to be red, while the more negative a* the color of the leaf color will be greener. For the more positive the value of b* means the leaf tend to yellow, whereas if the b* value negative the leaf tend to be colored blue. For leaf brightness level, the greater the L* value, the brighter the leaf.

In Table 3, it can be seen that the treatments of paclobutrazol 0 ppm, light shading, moderate shading and heavy shading indicated the color tends toward yellowish-green because it had a minus value of a * and positive b*. Whereas for paclobutrazol concentration 1 ppm, 2 ppm and 3 ppm in light, moderate and heavy shading showed reddish-yellow (orange) with a little green and yellow color because it had positive value of a* and greater positive b*. The higher concentration of paclobutrazol leaf green color looked lesser toward the red. Increasing levels of shading on the same level of paclobutrazol made leaf green color decreased toward the red.

The use of paklobutazol can enhance the formation of carotenoids in the leaf and increases leaf color. According Tekalign *et al.* (2005). Paclobutrazol application can also increases the carotenoid pigments in the leaves of potato plants.

Reddish yellow color performance was very firmly on the plants treated with paclobutrazol compared with those not given paclobutrazol, it was presumably because the smaller leaf size resulting more concentrated pigments that generated older leaves appearance for each area of leaf. While in heavier shading, older red color was due to the formation of a smaller leaf area coupled with the application paclobutrazol (2 ppm and 3 ppm) extremely reduced leaf area.

In Table 3 on consumer acceptance based on canopy structure and leaf color of *Begonia rex-cultorum* 'Marmaduke' noted that the shape of canopy structure preferred was the plant with compact form with lots of buds and shorter plant height.

Table 3 shows the plants applied with 2 ppm and 3 ppm paclobutrazol at all shading levels tended to be preferred as the compact performance led panelists to rank the highest value. While for the color, the panelists preferred the reddish-yellow leaf color (orange), in addition it was acquired by giving 2 ppm and 3 ppm paclobutrazol in moderate and heavy shading.

Based on consumer acceptance test results known that the most preferred *Begonia rex-cultorum* 'Marmaduke' plants were paclobutrazol treated plants, because the plants appeared more attractive and interesting with a compact form and tend to red color. Plants without paclobutrazol application were not preferred even appeared in larger with greater height and leaf area. This was because the form structure is less compact, the petiole seemed too long and large leaves made the plants look less balanced. As for the color, plants which were not applied with paclobutrazol tended to be green with little orange-colored pigment.

The use of retardants such as paclobutrazol is very important in ornamental industrial plants. Paclobutrazol has been used to suppress stem elongation in many plant species such as chrysanthemum, geranium, and other ornamental plant varieties (Foley and Keever, 1991). Paclobutrazol treated plants generally appear shorter and more compact, because it is more easily handled during the production and marketing period (Karlsson et al., 1992). While a compact potted plant is necessary, because it is more attractive, easier handling and delivery with minimal damage, also has a long life display for selling without causing etiolation symptoms and quality decrease (Banko & Stefani, 1988).

Table 3: The analysis of color appearance and consumer acceptance of ornamental plants

Treatments	Analysis Result			Consumers acceptance	
	L*	a*	b*	Leaf Color	Shoot Structure Shape
n_1p_0	35,38	-12,41	23,87	1,94 i	2,56 f
n_1p_1	25,37	-6,84	18,44	4,26 f	6,15 cd
n_1p_2	23,36	-0,91	16,53	6,09 e	7,76 b
n_1p_3	19,80	3,74	12,42	7,85 bc	9,74 a
n_2p_0	28,41	-5,70	21,08	3,44 fg	3,71 ef
n_2p_1	26,30	-1,49	19,42	6,50 de	7,00 bc
n_2p_2	26,28	-3,26	20,41	9,24 a	9,62 a
n_2p_3	22,86	3,25	15,23	9,03 ab	7,18 bc
n_3p_0	34,99	-8,59	26,54	2,50 gi	2,44 f
n_3p_1	29,84	-4,53	21,60	7,68 cd	5,06 de
n_3p_2	23,11	3,92	12,35	9,12 ab	6,79 bc

Note: The average values followed by a same letter are not significantly different according to Friedman Test at 5% level.

Ranking value of a small sequence indicates the treatment is not preferable to the rank of major to the most preferred. (n_1 = light shading, n_2 = moderate shading, n_3 = heavy shading; p_0 = 0 ppm paclobutrazol; p_1 = 1 ppm paclobutrazol; paclobutrazol p_2 = 2 ppm, and p_3 = 3 ppm paclobutrazol).

Figure 1:
Begonia rex-cultorum 'Marmaduke' differences structure of plant canopy is due to treatment paklobutrazol at different level (a) Paklobutrazol treatment at mild level (N_1); (b) paklobutrazol treatment at moderate level (N_2) ; (c) Paklobutrazol treatment at advance level (N_3) in the observation of 12 WAT (picture from left to right shows an increase of paklobutrazol concentration from 0 ppm, 1 ppm and 3 ppm).

Conclusion and Suggestions

Conclusion

There was interaction between shading levels and paclobutrazol application concentration on average leaf area. Application of paclobutrazol concentration of 3 ppm with heavy shading generated the smallest average leaf area, whereas treatment without paclobutrazol application with heavy shading level generated the widest average leaf area at 12 weeks after treatment.

Light shading treatment led to lower Specific Leaf Area (SLA) when compared to heavy shading. While giving paclobutrazol 3 ppm treatment could reduce plant height, canopy diameter, average petiole length, age of buds emerging, petiole diameter, and Specific Leaf

Area (SLA), but could increase the number of buds and number of leaves when compared with treatment without paclobutrazol. Paclobutrazol applications treatments (1 ppm, 2 ppm, and 3 ppm) on all shading levels (light, moderate, and heavy) generated plants with a form quality of canopy structure and leaf color that were most preferred by consumers compared to no paclobutrazol application (0 ppm) at all shading levels.

Suggestion

Based on the experimental results, it can be suggested that need further research on the use of paclobutrazol in application method, concentration and application dose of different begonia plants combined with other treatment factors such as frequency of watering, nutrient concentration and dosage, type of planting medium and various temperature.

References

Banko, T. J. and M. A. Stefani (1988). Growth Response of Selected Container-grown Bedding Plants to Paclobutrazol, Uniconizole, and Daminozide1. J. Environ. Hort, 6(4): 124-129.

Chaney, W. R. (2004). Growth Retardants: A Promising Tool for Managing Urban Trees. Department of Forestry and Natural Resources Purdue University, West Lafayette. Available online at: http://www.extension.purdue.edu/extmedia/FNR/FNR-252-W.pdf (cited 18 November 2010).

Conover, C. A. (1994). Angel-Wing Begonia Growth and Water Requirements Affected by Paclobutrazol. Available online at: http://mrec.ifas.ufl.edu/Foliage/Resrpts/rh_94_4.htm (cited 25 Oktober 2010)

Cremlyn, R. J. (1991). Agrochemicals: Preparation and Mode of Action. John Wiley & Sons Ltd. England. Pp: 278-280.

Dole, J. M. and H. F. Wilkins (2005). Floriculture: Principles and Species. Pearson Prentice Hall. New Jersey. Pp: 324-327.

Foley, J. T. and G. J. Keever (1991). Growth Regulators and Pruning Alter Growth and Axillary Shoot Development of *Dianthus1*. J. Environ. Hort. 9(4):191-195.

Gardner, F. P., R. B. Pearce and R. L. Mitchell (1991). Fisiologi Tanaman Budidaya (Terjemahan). UI- Press. Jakarta. 426 pp.

Handreck, K. and N. Black (1986). Growing Media for Ornamental Plants and Turf. New South Wales University Press. PO Box 1 Kensington NSW Australia 2033. Pp: 358-365.

Karlsson, M. G., J. W. Werner and J. T. Hanscom (1992). Growth Regulator Effects in Seed Propagated Begonia x Tuberhybrida. University of Alaska Fairbanks. Available online at http://www.uaf.edu/files/snras/C90.pdf (cited 20 Juni 2011).

Latimer, J. G. (2009). Selecting and Using Plant Growth Regulators on Floricultural Crops. College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University. Available online at: http://pubs.ext.vt.edu/430/430-102/430-102.pdf (cited 20 Juni 2011).

Mahgoub, M. H., N. G. Abd El Aziz and A. A. Youssef (2006). Influence of Foliar Spray with Paclobutrazol or Glutathione on growth, Flowering and Chemical Composition of *Calendula officinalis* L. Plant. J. App Sci Res. 2(11): 879-883.

Mahoney, S. R., S. Ghosh, D. Peirson and E. B. Dumbroff (1998). Paclobutrazol Affects the Resistance of Black spruce to High Light and Thermal Stress. Tree Physiology, 18: 121-127.

Mansuroglu, S., O. Karaguzel, V. Ortacesme and M. S. Sayan (2009). Effect of Paclobutrazol on Flowering, Leaf and Flower Colour of *Consolida orientalis*. Pak. J. Bot., 41(5): 2323-2332.

Masyhudi, M. F., Debora Herlina and Kristina Dwiatmini (1999). Paclobutrazol Sebagai Bahan Perangsang Pembungaan Tanaman Melati (*Jasminum sambac*). Jurnal Penelitian Pertanian, 18(1): 61-68.

Matsoukis, A. S., A. C. Sereli, I. D. Dimopoulos and A. Kamoutsis (2001). Response of *Lantana camara* L. subsp. camara to Paclobutrazol and Shading. Department of General Sciences, Agricultural University of Athens. Athens, Greece. Availble online at: http://ginkgo.cisti.nrc.ca/RPAS/rpv?hm=

HInit&journal=cjps&volume=81&afpf=P00-140.pdf (cited 18 November 2010).

Milandri, S. G., C. P. Laubscher and P. A. Ndakidemi (2008). Hydroponic Culture of *Gladiolus tristis*: Application of Paclobutrazol for Flowering and Height Control. AF. J. Biotech, 7 (3): 239-243.

Nazarudin, M. R. A., R. M. Fauzi and F. Y. Tsan (2007). Effects of Paclobutrazol on The Growth and Anatomy Of Stem And Leaves of *Syzygium campanulatum*. J. Tropic Forest Sci 19(2): 86–91.

Poole, R. T. and C. A. Conover (1992). Paclobutrazol and Indoor Light Intensity Influence Water Use of Some Foliage Plants. Proc. Fla. State Hort. Soc. 105: 178-180.

Prasetyo, H., Ulianna and B. Gonggo M. (2006). Pola Pertumbuhan Tanaman Jahe Merah dengan Intensitas Naungan dan Dosis Pupuk KCl pada sistem Wanafarma di Perkebunan Karet. Jurnal Akta Agrosia, 9(1): 19-24.

Sitompul, S. M. and B. Guritno (1995). Analisis Pertumbuhan Tanaman. Gadjah Mada University Press. Yogyakarta. Hlm: 113-115.

Sopandie, D., M. A. Chozin, S. Sastrosumarjo, T. Juhaeti and Sahardi (2003). Toleransi Padi Gogo terhadap Naungan. Hayati, 10(2): 71-75.

Syahid, S. F. (2007). Pengaruh Retardan Paclobutrazol Terhadap Pertumbuhan Temu Lawak (*Curcuma xanthorrhiza*) Selama Konservasi *In Vitro*. Jurnal Littri, 13(3): 93 – 97.

Tebbitt, M. C. (2005). Begonias: Cultivation, Identification and Natural History. Timber press. Inc. Oregon, U.S.A. 272 pp.

Tekalign, T. (2005). Response of Potato to Paclobutrazol and Manipulation of Reproductive Growth Under Tropical Conditions. PhD thesis, University of Pretoria. Available online at: http://upetd.up.ac.za/thesis/available/etd-02082006112218/unrestricted/11chapter11.pdf (cited 24 Juli 2011).

Thompson, M. L. and E. J. Thompson (1981). Begonias: The Complete Reference Guide. First Edition. Times Books. New York. 356 pp.

Wang, S. Y., T. Sun and M. Faust (1986). Translocation of Paclobutrazol, a Gibberellin Biosynthesis Inhibitor, in Apple Seedlings. Plant Physiol, 82: 11-14.

Asian Economic and Social Society
Rasul Pur Tarar, 52111, Distt: Hafizabad, Pakistan.
Contact number: +923217609189
Email: ajardeditor@gmail.com, editor@aessweb.com
Website: www.aessweb.com