Effect of Paclobutrazol in micro tuberization of Potato (*Solanum tuberosum* L.) cultivar Granola Kembang and Repita

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Abstract. The seeds or seedlings are the main key to the success of potato cultivation. So one way to obtain high quality of potato seeds is to do with in vitro plant propagation or tissue culture. The research was conducted at Tissue Culture Laboratory, UPT Seed Horticulture Johor Building Medan, used the completely randomized design with two factors. The first factor was potato cultivar (K₁: Granola Kembang, and K₂: Repita), and the second factor was paclobutrazol M₁ (MS + 0 ppm Paclobutrazol), and M₂ (MS + 10 ppm Paclobutrazol). The results showed that the concentration of paclobutrazol significantly affected on the plant height, the number of shoots, the number of micro tuber, the micro tuber diameter, and the fresh weight of micro tuber.

1. Introduction
The high nutritional content of potato (*Solanum tuberosum* L.) causes potato to become one of the commodities that has priority for development. Potato needs tend to increase along with the increase in population, rising incomes and the growing industry food processing. This situation resulted in the expansion of potato planting and an increase in demand for quality and high-quality potato seeds [1]. According to Central Bureau of Statistics (BPS) [2], the production of potato crops (*Solanum tuberosum* L.) from 2011 to 2014 increased by 1.348 million tons in 2014. In 2015, potato production decreased by 9.54%, which is around 1.219 million tons, with the harvest area of 66.983 ha. It is caused by several factors such as market competition from China, Taiwan, and Australia, the venture capital needed is quite high, pest potential attack potato is quite a lot, and use of seed potato quality is still low [3].

The seeds or seedlings are the main key to the success of potato cultivation. One of the ways to obtain high quality potato seeds is to do with *in vitro* plant propagation or tissue culture [4]. *In vitro* propagules that are widely used to produce quality potato seeds are micro shoots and G₀ micro tubers. Micro cuttings and micro tubers produce more tubers than ordinary tuber seeds [5,6].

Applications of culture techniques *in vitro* through micro breeding can produce seeds in large quantities in the time relative short, without depend on the climate and season as well as the cost of providing seedlings relatively cheaper than imported seed [5]. How to get best quality of potato micro-tubers in a relatively short time, it is necessary to provide growth regulators on the media, because the formation of micro-tubers in vitro depends on the ratio of growth substances, between upgrading and
reducing in tuber formation. This ratio can be done with encouraging, slowing growth or a combination of both. Growth-slowing substances play a role in the formation of tubers between them are coumarin and paclobutrazol, while the driving substance is cytokinin [7].

According to [1], the concentrations of sugar and paclobutrazol which were effective in inducing micro tubers of Atlantic varieties were 150 g/l and 5 ppm, respectively. Meanwhile, the optimal sugar concentration in inducing tubers is 150 g/l.

The objective of the research was to find out the effect of paclobutrazol in the induction of potato micro tubers (*Solanum tuberosum* L.) cultivars Granola Kembang and Repita.

2. Materials and methods

The materials used in this study are autoclave, Laminar Air Flow Cabinet (LAF), tweezers, scissors, scalpel, Erlenmeyer, oven, gas stove, tips dropper, petri dish, funnel, culture bottle, measuring cup, label paper, bunsen lamp, pH meter, micropipette, test tube, culture rack, analytical balance, tissue and camera. The plant material used is the bud of potato (*Solanum tuberosum* L.) cultivars Granola Kembang and Repita, which has been subculture originating from Faculty of Agriculture, Universitas Sumatera Utara, Medan, 70% alcohol, distilled water, paclobutrazol, basic materials Murashige and Skoog (MS) media, sucrose, agar, detergent, 0.1 N NaOH, 0.1 N HCl, aluminium foil.

This study was prepared with the basic pattern of Two-Factors Completely Randomized Design (CRD), namely, factor I. Potato cultivars (K1 = Granola Kembang, and K2 = Repita), factor II. Paclobutrazol (M1 = MS + 0 ppm paclobutrazol (control), M2 = MS + 10 ppm paclobutrazol).

The research data were analysed using variance, and if the results of variance were significantly affected, the analysis was continued using the DMRT (Duncan Multiple Range Test) at the test level α = 5%

The parameters observed in this study were the plant height plant (cm), number of axillary buds per plant (buds), age tuber formation (d), the number of tubers per plant (bulb), the diameter of the bulbs (mm), and fresh weight of tubers per plant (g).

3. Results and discussion

The effect of cultivars has no effect on the entire of variable observation. The concentration of paclobutrazol have significant different on the observation variables of plant height, number of axillary buds crop, the number tubers per plant, and diameter of the bulb, but had no significant different with age of tuber formation. The interaction between cultivars and paclobutrazol concentration did not significantly affect for all observed variables.

The effect of Paclobutrazol had a significant different on potato plant height (table 1-3), with the best treatments on M1 with a mean value of 7.13 cm and significantly different with M2 with a mean value of 6.96 cm. Total of axillary buds per plant was the best on the M1 with a mean value of 4.47 and significantly different to the treatment of M1 with a mean value of 3.69. Paclobutrazol had no real effect on the age of tuber formation. Variables observations of total tubers per plant showed that best treatment found on M2 with the average value of 0.92 and significantly different toward M1 with a mean value of 0.72. The best treatment for bulb diameter was found in M2 treatment with an average value of 5.76 mm and significantly different from treatment M1 with an average value of 4.54 mm. The parameter of fresh weight of tubers per plant can be seen that the best treatment found on M2 treatment with a mean value of 0.21 g and significantly different to the treatment of M1 with a mean value of 0.17 g (table 1-3).

From the statistically obtained that the treatment of paclobutrazol concentration has a significant effect on plant height growth. This is thought to be the result of the application of paclobutrazol in the form of retardants which can slow down vegetative growth and gibberellin biosynthesis, thereby suppressing the height growth of potato plantlets. This is also supported by the opinion of [2], which states that paclobutrazol is a growth regulator which has the property of reducing tissue metabolism and can slow vegetative growth and slow down gibberellin biosynthesis which functions in the process of elongation of cells and plant tissues.
Table 1. Average data of potato (*Solanum tuberosum* L.) cultivars.

| Observed Variables                  | Cultivars          |
|-------------------------------------|--------------------|
|                                     | K₁ (Flower Granola) | K₂ (Repita)       |
| Plant height (cm)                   | 7.003              | 7.078             |
| Number of axillary shoots per plant (shoots) | 3.917              | 4.250             |
| Age of tubers (d)                   | 102.889            | 103.611           |
| Number of tubers per plant (Bulbs)  | 0.806              | 0.833             |
| Bulbs diameter (mm)                 | 5.070              | 5.238             |
| Fresh weight bulbs per plant (g)    | 0.193              | 0.189             |

Table 2. Average data of concentration paclobutrazol potato (*Solanum tuberosum* L.).

| Observed Variables                  | Concentration of Paclobutrazol |
|-------------------------------------|--------------------------------|
|                                     | M₁ (0 ppm)                    | M₂ (10 ppm)                  |
| Plant height (cm)                   | 7.125 a                       | 6.956 b                      |
| Number of axillary shoots per plant (shoots) | 3.694 b                       | 4.472 a                      |
| Age of tubers (d)                   | 93.194                        | 113.306                      |
| Number of tubers per plant (Bulbs)  | 0.722 b                       | 0.917 a                      |
| Bulbs diameter (mm)                 | 4.543 b                       | 5.765 a                      |
| Fresh weight bulbs per plant (g)    | 0.170 b                       | 0.211 a                      |

Table 3. Data on interaction between cultivars and concentration of paclobutrazol.

| Observed Variables                  | Interaction of Cultivars and Concentration of Paclobutrazol |
|-------------------------------------|------------------------------------------------------------|
|                                     | K₁M₁ | K₁M₂ | K₂M₁ | K₂M₂ |
| Plant height (cm)                   | 7.111 | 6.894 | 7.139 | 7.017 |
| Number of axillary shoots per plant (shoots) | 3.778 | 4.056 | 3.611 | 4.889 |
| Age of tubers (d)                   | 89.278 | 116.500 | 97.111 | 110.111 |
| Number of tubers per plant (Bulbs)  | 0.667 | 0.944 | 0.778 | 0.889 |
| Bulbs diameter (mm)                 | 4.204 | 5.936 | 4.882 | 5.594 |
| Fresh weight bulbs per plant (g)    | 0.172 | 0.214 | 0.168 | 0.209 |

In parameter number of axillary shoots of paclobutrazol gave a significantly effect. This showed that the number of axillary shoots of potato plants is influenced by the composition of the media, where the media applied with paclobutrazol tends to experience a slowdown in shoot elongation, thus encouraging the formation of micro tubers. Meanwhile, the growing number of plant branches was due to the encouragement of micro tuber formation in the potato branches in tissue culture. This is supported by the opinion of [8] which states that the number of branches is influenced by the composition of the media used. It can be seen that the highest number of branches was found in media with retardant.

Paclobutrazol application had a significant effect on the micro tuber diameter of potato plants. The potato micro tubers produced from the application of paclobutrazol are classified into quality micro tubers. The difference in diameter is thought to be due to the influence of paclobutrazol, which functions as a retardant that can encourage micro-tuber initiation, and nutrition distribution is more focused on tuber growth so that the tubers formed are large. This is supported by the research of [7] which states that coumarin treatment has a significant effect on the parameter of micro tuber diameter per plantlet of 0.519 mm. This is because coumarin as a retardant function to slow down vegetative growth. With the delay in vegetative growth, it can induce and encourage the initiation of micro tubers, and the distribution of nutrients is more focused on the growth of the tubers so that the tubers
that are formed are large in size. This is also supported by the statement of [9] which states that the criteria for good quality micro tubers are tubers with a wet weight of more than 100 mg per tuber and a diameter of 5-10 mm and have dry matter of more than 14%. Micro tubers can grow directly from the axillary shoots of explants and indirectly on the axillary or new shoot terminals.

The application of paclobutrazol can increased the fresh weight of tubers per plant. This is thought to be due to the increased in chlorophyll caused by the application of paclobutrazol so that photosynthetic activity increases and the results of photosynthesis are used to form tubers. Slow vegetative growth due to the application of paclobutrazol will also slow down the synthesis of gibberellin which is thought to play a role in reducing the amount of photosynthesize used for plant vegetative growth, so that the wet weight of the tubers increases. Accordance with [10] which states that paclobutrazol is effective through leaves and soil. The substance is translocated through the xylem tissue and reaches the shoots. The application of paclobutrazol increases the chlorophyll content of leaves so that photosynthetic activity can run well and the absorption of shoots stimulates the results of photosynthesis used for the formation of carbohydrates in tubers so that they have a significant effect on tuber/sample fresh weight.

4. Conclusions
The effect of paclobutrazol had a significant different on plant height, number of axillary shoots per plant, number of tubers per plant, tuber diameter, and tuber fresh weight per plant but had no significant effect on tuber formation age. The cultivars had no significant effect on all observed parameters.

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