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G0 Seed Potential of The Aeroponics Potatoes Seed

by Eni Sumarni

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G0 Seed Potential of The Aeroponics Potatoes Seed In The Lowlands With A Root Zone Cooling Into G1 In The Highlands

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Abstract

In tropical country likes in Indonesia, potato seeds that originated from temperate zone can only be produced in low temperature of highland. Besides this way has many limitation of productivity, it often causes soil erosion. To minimize environment destroying risk tuber seed production in lowland is a challenge. This research was done to trace that modified root zone cooling method of aerophonic system can be applied to produce high quality of tuber seeds in lowland. The First Generations (G0) of var. Atlantic and var. Granola were used as plant materials, and randomized block design (RBD) with four replications was applied in this research. Data regarding with vegetative as well as tuber production parameters were analyzed using Coefficient of variance (ANOVA) and continued with the least significant difference test (LSD; p = 5%). The results showed that aerophonic generated seeds (G0) had vigorous growth and could produce the normal G1. In term of tuber yield component and number of leaves var. Atlantic showed higher than var. Granola did. The comparison of seed weight between G0 and G1 was about 10 grams and 54 g on average, respectively. Since the size and weight of such G1 could be categorized as Large (L) in term of commercial seed market, It's implied that the lowland modified aerophonic system could be nominated as a prospective method for producing G0 tuber seed in the future.

Keywords: Aeroponics, atlantic, granola, potatoes seed

Potensi Bibit G0 Dari Bibit Kentang Aeroponik Di Dataran Rendah Dengan Akar Zona Pendingin Menjadi G1 Di Dataran Tinggi

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Abstrak

Di negara tropis seperti di Indonesia, bibit kentang yang berasal dari zona sedang hanya dapat diproduksi pada suhu rendah di dataran tinggi. Selain itu cara ini memiliki banyak keterbatasan produktivitas dan sering menyebabkan erosi tanah. Meminimalkan resiko dampak kerusakan lingkungan akibat produksi benih umbi di dataran rendah adalah sebuah tantangan. Penelitian ini dilakukan untuk mengkaji bahwa metode zona akar pendingin sistem aeroponik dapat diterapkan untuk menghasilkan benih umbi kentang kualitas tinggi di dataran

rendah. Generasi Pertama (G0) dari *var. Atlantik* dan *var. Granola* digunakan sebagai bahan penelitian, dan rancangan acak kelompok dengan empat ulangan digunakan dalam penelitian ini. Data mengenai vegetatif serta parameter produksi umbi dianalisis menggunakan Koefisien varians (ANOVA) dan dilanjutkan dengan uji BNT (LSD; p = 5%). Hasil penelitian menunjukkan bahwa aeroponik biji yang dihasilkan (G0) memiliki pertumbuhan yang kuat dan bisa menghasilkan G1 yang normal. Dari segi produktivitas dan jumlah daun, *var. Atlantic* menghasilkan produktivitas yang lebih tinggi serta jumlah daun yang lebih banyak dibandingkan *var. Granola*. Perbandingan berat biji antara G0 dan G1 adalah rata-rata sekitar 10 gram dan 54 g untuk masing-masing generasi. Ukuran dan berat dari G1 tersebut dapat dikategorikan sebagai ukuran besar dan berpotensi komersial untuk dipasarkan. Dari hasil penelitian yang telah dilakukan, dapat disimpulkan bahwa sistem aeroponik dataran rendah termodifikasi bisa diterapkan sebagai metode prospektif untuk memproduksi benih umbi kentang G0 di masa depan.

Kata kunci : Aeroponik, atlantic, granola, bibit kentang

INTRODUCTION

Potato production in Indonesia has still lower than the production from subtropical countries. Average production of potatoes in Australia reached 35.9 ton per hectare, while the production in Indonesia reached only 16.5 ton per hectare (Central Bureau of Statistics, 2010). Even in 2013-14 the national production tended to decrease. One of the causes was unavailability of qualified seeds. Data from Directorate of Seed and Means of Production (2007) showed that only 7.4% of the farmers used the certificated and qualified seeds of potato. Few breeders afforded to establish qualified seeds of potato. Moreover, the breeding process can only be done on highland, which runs the risk of erosion and environmental damages. Scarcity of qualified seeds of potato does not only bring implication toward prices, but also toward actions and responses of the farmers to breed repeatedly and without control the quality. Therefore, in improving the application of qualified seeds, results of the research by Sumarni *et al*., (2014) has succeeded in establishing G0 seeds at lowland with more tubers produced by applying the most relevant root zone cooling system.

Technologies to increase production of potato seeds have been developed in some countries, for instance, China, United States of America, and Australia, which so-called aeroponic breeding technique (Otazu, 2010). The aeroponic system in Kenya has produced 800 tubers per crop (Farran and Mingo, 2006), 50-100 tubers per crop (Muthoni *et al*., 2010; 2011; Mbiyu, *et. al*., 2012). The aeroponic technique has started to be developed in Indonesia on wet tropical highland (Sumarni, *et al*., 2011; Sumarni *et al*., 2014). Such technique could produce more potato tubers than the conventional ways, which produce less than 10 tubers per crop.

In general, farmers at the highland cultivate vegetables on beds in area having slope more than 30% without any effort to preserve land and control the erosion. Besides that, land at the center of potato cultivation was endemic to nematode, which damaged the potato tubers

(Fuglie *et. al*., 2005; Lisnawati, 2005). The aeroponic technique by climatic modification of root zone for potato seed production at wet tropical lowland has also been developed and produced tubers. The aeroponic technique along with the application of root zone cooling is an effort to modify climate at the root zone of potatoes, which are grown on lowland to achieve optimal growth and tuber formation (Sumarni *et al*., 2013a; 2013b). Yield of G0 seeds by aeroponic system at the lowland has produced 325-579 tubers/1.5 m^2 (Sumarni *et al*., 2013a; Sumarni and Sudarmadji, 2014). It is suggested to support land conservation on highland, produce continuous and healthy seeds of potato, as well as expand the production area of potato seeds. The resulted seeds of potato from such aeroponic system on lowland are zero generation (G0). G0 potato is seeds of plantlet as a result of tissue culture that was grown aeroponically. G0 seeds were the first seeds that have some superiority, such as free diseases and viruses. It is expected that potato cropping by the application of G0 from lowland could increase production of potato in Indonesia. G0 seeds that derived from results of the research on lowland should perform a viability test in order to become G1. The first seeds (G0) that were grown on this screen will produce G1. Therefore, objective of this research was to gain potential G1 seed in the highlands of GO seeds produced through aeroponics system in the lowlands through the root zone cooling applications.

MATERIALS AND METHODS

The research on productivity of G0 seeds, Atlantik and Granola varieties, as a result of aeroponic system by the application of root zone cooling derived from lowland (115 m asl) was conducted on highland at Embel Village, Pandansari District, Paguyangan Subdistrict, Brebes Regency, Central Java. The location is at the altitude 1100 m asl (above sea level).

Equipments used in this research included termohygrometer to measure temperature and humidity level around the screen, meters to measure height of the crop, sprinkler to water the crops, and analytic scales to weigh weight of the harvested seeds G1. The first seeds (G0) used in this research derived from seed production through aeroponic system by the application of root zone cooling on lowland at the altitude 115 m asl. G0 seeds as a result of aeroponic on lowland were grown in screens following the dormant period and the emergence of shoots, which were ready to be planted.

Materials used in this research included polybags, screen, ABmix nutrition, pesticides to control pest and disease, chopped pine leaves and compost. Varieties used in this research included G0 seeds of Atlantic and Granola varieties that derived from aeroponics by root zone cooling at lowland. Average weight of G0 seeds were 1-2 gram. The research used the

Randomized Block Design with 4 (four) replications. Polybag used has a diameter of 25 cm. Data analysis used the coefficient of variance and followed by the Least Significant Difference (LSD) test at level $\alpha = 5\%$. The planting process of G0 in screen is presented in Figure 1.

Figure 1. The planting process of G0 for Atlantic and Granola varieties in screen

RESULTS AND DISCUSSIONS

1. Temperature and Humidity in Screen House

Minimum averaged temperature in screen house during growth and formation of tubers was 9.7°C and maximum averaged temperature reached 33 °C. Daily averaged temperature in the morning (at 7.00) reached 14.51°C, in the midday (at 12.00) reached 23.71°C, in the afternoon (at 17.00) reached 18.80°C and in the night (at 20.00) reached 14.83°C. Daily minimum averaged humidity (RH) in screen reached 60% and maximum RH reached 97%. Averaged humidity in screen during the growth period was 82.8% (Table 1). Temperature is the main factor that controls phenological development of potatoes (Streck *et. al.*, 2007). Productivity of potatoes will be high under daily averaged temperature 21°C. Cold temperature at night is essential for dry matter and carbohydrate accumulation (Grose, 2012). Higher temperature in screen house than the environment outside the screen house was due to interaction between micro climate and materials of the screen house (Impron *et. al.*, 2008).

Growth period of potato requires different temperature for each period of growth. Area that having maximum temperature 30°C and minimum temperature 15°C is very suitable for potato growth in comparison with relatively constant temperature, 24°C. Average humidity for potato is about 80-90% (Struik, 2008).

Table 1. Average temperature and humidity in screen at 1-100 DAP (days after planting)

Micro Climate	Period			
	Morning	Midday	Afternoon	Night
Temperature (°C)	14.51	23.72	18.80	14.83
Humidity (%)	91.36	62.56	82.49	92.55

Note : in the morning at 07.00, in the midday at 12.00, in the afternoon at 17.00, at night at 20.00

Temperature in screen, where G0 was grown in this research, was still optimal for growth and tuber initiation. High temperature in screen at 12.00 was caused maximum radiation during the period and due to greenhouse effect. The greenhouse effect is a short wave radiation, which come into the screen through the roof and then transformed into long wave radiation, after that this long wave radiation could not go out from the screen and trapped in it, and such condition will increase temperature inside the screen. Structure of the greenhouse interacts with climatic parameters around the greenhouse, and then creates micro climate inside it that is different from climatic parameters around the greenhouse (Suhardiyanto, 2009).

2. Height of Potato Crop

Growth of two varieties G0 that derived from aeroponic system at the lowland by the application of root zone cooling, in which the productivity has been tested at highland, have produced different height of crops (Table 2). G0 seed of Atlantic variety showed higher crops than Granola variety at 35 DAP (days after planting), 42 DAP, 49 DAP, 63 DAP, and 70 DAP. Heights of Atlantic variety ranged 29.26, 54.61, 58.43, 63.00, and 69.96 cm, respectively. Heights of Atlantic variety are higher than description of Atlantic variety (Ministry of Agriculture, 2000). Heights of Granola variety ranged 16.18, 32.43, 42.39, 43.62, and 52.19 cm, respectively. Heights of Granola variety approached to the previous results on a review of production and quality of potato cloned tubers and its suitability as raw materials for French fries and potato chips (Kusmana and Basuki, 2004).

Results of the research on productivity test of seven potato clones, Atlantic variety showed the crop height for about 15.37 cm at 70 DAP, while Granola variety produced the crop height for about 49.81 cm (Aulia *et al*., 2014) and results of other research showed height of the crop for about 30.50 cm (Handayani *et.al*., 2011). Results of the previous research on G1 potato seeds from stem cutting, height of Granola variety reached 25 cm (Lestari *et. al*., 2014).

Previous studies of seed potato production in lowland areas, cools the top of the plant have poor growth, since the age of 23 days of plant death (Ma'rufatin, 2011). So that, yield of G1 in this research showed that G0 seeds resulted from aeroponic system on lowland by the application of root zone cooling have better growth than height of the crops.

Table 2. Height of potatoes for Atlantic and Granola varieties

Variety	Height of crop (cm)				
	35 DAP	42 DAP	49 DAP	63 DAP	70 DAP
Atlantic	29.26 a	54.61 a	58.43 a	63.00 a	69.96 a
Granola	16.18 b	32.43 b	42.39 b	43.62 b	52.19 b

Note : Numbers followed by the same letters in the same column showed insignificant differences at level $\alpha = 5\%$ LSD test

3. Numbers of Potato Leaf

Numbers of leaf for Atlantic and Granola varieties at 35 DAP, 42 DAP, 49 DAP, 63 DAP and 70 DAP have provided different results (Table 3). Numbers of leaf for Atlantic variety produced more leaves than Granola variety. Increasing numbers of leaf for Atlantic variety were as follow: 51.65 leaves (35 DAP), 70.95 leaves (42 DAP), 98.64 leaves (49 DAP), 107.87 leaves (63 DAP) and 110.81 leaves (70 DAP). Numbers of leaf for Granola variety were 27.70 leaves (35 DAP), 47.70 leaves (42 DAP), 67.35 leaves (49 DAP), 73.50 leaves (63 DAP) and 79.50 leaves (70 DAP).

Table 3. Numbers of leaf for Atlantic and Granola varieties

Variety	Height of crop (cm)				
	35 DAP	42 DAP	49 DAP	63 DAP	70 DAP
Atlantic	51.65 a	70.95 a	98.64 a	107.87 a	110.81 a
Granola	27.70 b	47.70 b	67.35 b	73.50 b	79.50 b

Note : Numbers followed by the same letters in the same column showed insignificant differences at level $\alpha = 5\%$ LSD test

Results for numbers of leaf showed that G0 seeds from aeroponic system at lowland, in which the productivity has been tested at highland, have shown well growth for numbers of leaf. Results of the previous research up to 70 DAP produced 58.83 leaves (Aulia *et al*., 2014). In leaf, chlorophyll plays very important role as light absorber to hold the photosynthetic process, more chlorophyll in leaf will make the photosynthetic runs well, so that the crops could produce more photosynthate. If the crops grow well, they will produce better yield as well (Nasrun, 2007).

4. Numbers of tuber per crop, Weight of tuber per tuber, and Weight of tuber per crop

Numbers of G1 tuber of two varieties in this research showed the same results, numbers of tuber per crop derived from Atlantic variety for about 4.56 tubers and Granola for about 4.83 tubers per crop (Table 4). These results were higher than the previous results, which achieved 3 tubers per crop (Lestari *et al*., 2014).

Weight of tubers per crop and weight of tuber per tuber of G1 that derived from both varieties showed different results. Atlantic variety showed higher weight of tubers per crop and weight per tuber than Granola variety. Weight of tuber per crop G1 of Atlantic variety reached 306.35 gram and weight per tuber reached 73.09 gram. Weight of tubers per crop G1 resulted from Granola variety reached 147.99 gram and weight per tuber reached 34.15 gram. Appearance of G1 seeds is presented in Figure 2.

Table 4. Numbers of tuber and weight of tuber

Variety	Number of tuber per crop (gram)	Weight of tuber per crop (gram)	Weight per tuber (gram)
Atlantic	4.56a	73.09 a	306.35 a
Granola	4.83a	34.15 b	147.99 b

Note : Numbers followed by the same letters in the same column showed insignificant differences at level $\alpha = 5\%$ LSD test

Based on grade sizes of potato seeds, they are classified into SS (<20 g), S (21-30 g), M (31- 60 g), and L (> 60 g) (Ummah and Purwito, 2009). The previous research on stem cutting produced G1 with weight of tuber per crop was just 33 gram and the highest yield of G1 was SS (< 20 gram) (Lestari *et.al*., 2014). G0 seeds from aeroponic system in this research have potential yield of G1. G0 seeds as a result of aeroponic by the application of root zone cooling at lowland, such as micro tubers, are easily to be managed during shipping, distribution, and storing due to their small sizes (Perez-Alonso *et. al*., 2010).

Figure 2. G1 seeds resulted from G0 of aeroponic system at lowland by the application of root zone cooling

Productivity of G0 by aeroponic system from Atlantic variety produced G1 seeds with the highest L size, while Granola variety produced G1 with the highest M size. G0 seeds from aeroponic system at lowland have high viability and productivity if they are grown at highland. G1 in this research was harvested at 100 DAP. G0 seeds by average weight of 1.5 gram could produce 17700 gram (17.7 kg) G1. These results are prospects for potato development and improvement at lowland in order to increase the production.

CONCLUSIONS AND SUGGESTION

G0 seeds from aeroponic system at lowland by the application of root zone cooling are highly potential to produce high qualified G1. Atlantic variety produced higher yield for height of crops, numbers of leaf, and weight of tubers than Granola variety. G0 seeds by average weight of 1.5 gram could produce 17700 gram (17.7 kg) G1. G0 seeds of Atlantic variety by aeroponic system at lowland could produce G1 by the highest size of L seeds.

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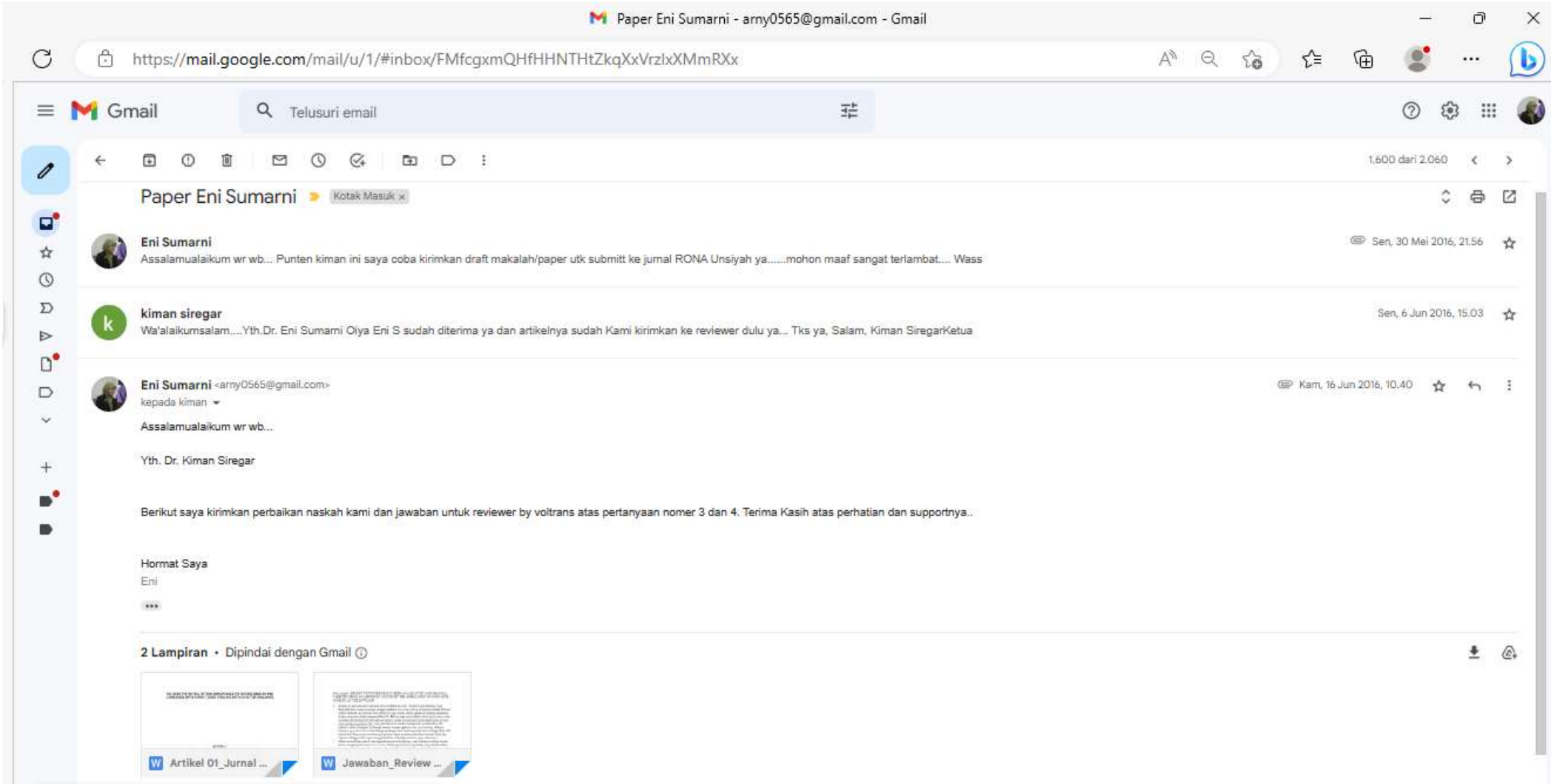
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Eni Sumarni <arny0565@gmail.com>
kepada kiman
Kam, 16 Jun 2016, 10.40
Assalamualaikum wr wb...
Yth. Dr. Kiman Siregar
Berikut saya kirimkan perbaikan naskah kami dan jawaban untuk reviewer by voltrans atas pertanyaan nomer 3 dan 4. Terima Kasih atas perhatian dan supportnya..
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