G1 Seed Potato Tuber Production from Apical Cutting Under Hydroponic Condition in Sembalun: Effect Of IAA Concentration and Plant Spacing

by Aluh Nikmatullah

G_1 Seed Potato Tuber Production from Apical Cutting Under Hydroponic Condition in Sembalun: Effect Of IAA Concentration and Plant Spacing

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Abstract

Availability of certified potato seed tubers is a major problem in potato cultivation in Indonesia. This was partly caused by lack availability of breeder seeds for the certification program. This research was conducted to assess the use of apical stem cuttings as a system for mass-production of G1 seed tuber under hydroponic condition. Experiment was conducted in a screen house located in Sembalun Timba Gading, Sembalun District, West Nusa Tenggara, at altitude of 1,200 m above sea level. The cuttings were planted in seedling trays filled with mixtures of rice paddy husk and coco-peat (4:1), and weremaintained for 2 weeks with daily watering using a mixture of hydroponic nutrients. Rooted cuttings were transferred to hydroponic frame filled with mixtures of rice paddy husk and coco-peat (4:1) (aggregate culture), and planted at different planting space, nutrients were supplied through an automated system twice a day, and insecticides/fungicides were applied as appropriate. All cuttings treated with IAA at concentration of 1, 3 and 5 ppm were successfully rooted, and the growth was influenced by concentration of IAA and length of IAA treatment. The best seedling growth was achieved on cutting treated with 1 ppm IAA for 30 minutes. In addition, planting space influenced cutting growth and production. Better growth rate and G_1 tuber were obtained at spacing of 15 x 15 cm, at which each cutting produced 5,2 tubers. However, the size of tuber produced in each treatment was mostly large for G_1 seedlings (more than 20 gr each). The results indicate that apical cutting is a possible approach for mass-propagation of G_o plants. Further work is now underway to optimize the system and to evaluate field performance of G_1 tuber for production of quality G_2 potato seed tuber.

Keywords: *Potato seed Tuber, hydroponics, apical cutting, IAA, planting space*

Introduction

Potato (S*olanum tuberosum* L.) is a plant belongs to *Solanaceae* family utilized as an important food due to high carbohydrates content and it is also contain vitamin B and Vitamin C. The demand for potato in Indonesia in 2012 was 1.3 million tons (Andriyanto et.al., 2013), while national production at the same year was 1.2 million ton (BPS, 2014). It is predicted that demand for potato in Indonesia will increase in accrodance with annual increase in population, welfare and increase utilization of potato as alternative staple food in Indonesia. On the other hand, there is a tendency that annual potato production in Indonesia is declining. In 2009, national potato production in Indonesia was 1,2 million tones and this production decresed to only 1 million tons in 2013 (BPS, 2014).

It is reported that the decline in potato production in Indonesia is caused by many factors including the use of low quality seed potato tubers due to lack availability and expensiveness of certified G_4 tubers used for commercial plantation. Baharuddin et al. (2012) suggested that the demand for commercial seed tuber in 2012 was 138,000 tons while seed tuber availability was only 8% of the demand, and thus 90% of farmers used consumption tuber for seed tuber. In order to increase the production of seed potato tuber, Indonesian government has priorities the development of seed potato industry and new centre for seed potato production in Indonesia. One potential area for national seed potato production in Indonesia is Sembalun District in East Lombok (Deptan, 2011).

At the meantime, availability of basic seed tubers (G_1 and G_2 tubers) in Indonesia are very limited due to limited number of institution which produced virus free potato plantlets and breeder seeds (G_0). In addition, lack availability and high price of G_0 seeds as well as high requirement for the production of G1 seeds which have to be produced inside screen house, contribute to the expensiveness of G1 seed tuber (price per tuber is between Rp.1,500 to Rp. 2,000). One possible solution to increase availability of G_1 seed tuber is by vegetative propagation of the G_0 plants *via* apical cutting. Each G_0 plants are comprised of 3 to 5 haulms, and thus potentially 3 additional G_0 plants can be obtained from stem cutting of the G_0 plant.

Successful propagation of plant from apical cutting deepens on capability of the cutting to produce adequate number and length of roots. In general, rooting formation in cutting can be promoted by exogenous application of auxin, such as Indole Acetic Acid (IAA), Indole Butyric Acid (IBA) and Naphtalene Acetic Acid (NAA) (Lestari, 2011). Effective exogenous auxin treatments depend on many factors including type of auxin applied, type of plant treated and concetration of exogenous auxin applied. Djamhuri (2011) stated that suitable NAA and IBA concentrations to promote root formation in hardworod of *Shorea leprosula* Miq was

100 ppm while for rooting of potato plantlet, suitable concentration of IAA or IBA was 1 ppm (Sugihono and Hasbianto, 2014). After the rooted cuttings are transferred to G_1 seed production plantation, growth and yield of the apical cuttings will be influenced by planting space. Planting space will contribute to competition to get water, nutrition and light and thus influence yield of the plant (Sutapradja, 2008). Suitable planting space for the production of G 2, G3 and G4 tubers in the field is 70 cm x 30 cm, while suitable planting space for production of G_1 seed tuber from G_0 tuber is 20 cm x 20 cm (Baharuddin et al., 2012). G_0 plants regenerated from apical cuttings commonly have 3 to 5 haulms while plant regenerated from apical cutting will only have one stem, and thus may require less planting space.

Materials and Methods

An experiment has been undertaken in screen house located in Sembalun Timba Gading Village, Sembalun District, East Lombok from March to July 2014. The experiments comprised of two stages: cutting stage and production of seed tuber from the cutting. The first stage of experiment was set according to Completely Randomized Design comprised of 3 different concentration of IAA (1, 3 and 5 ppm). The second stage of experiment was set according to Factorial Completely Randomized Design , with two factors: IAA concentration (1, 3 and 5 ppm) and planting space (15 cm x 15 cm; 20 cm x 20 cm; and 25 cm x 25 cm). All treatments were made in triplicates.

Apical stem cuttings (3 nodes length) were made from 3 weeks-old G_0 plants, and the base of cuttings dipped IAA solution (at concentration 1, 3 or 5 ppm) for 30 minutes, Cuttings were planted to seeding trays contained mixtures of coco peat and rice paddy charoal (3 : 1). The cuttings were maintained under shading with regular nutrient watering with hydrophynic nutrients at concentration as suggested by the supplier (PT Amris Hidroponic, Bogor). Cutting growth were observed after two-weeks of planting, and cuttings were then transplanted onto experimental plot (80 cm x 200 cm) containing media mixture as described previously, and planted at different planting space as appropriate. The hydroponic nutrients as previously decribed were given twice a day, at 9 am and 3 pm, by automatic watering system. The plants were also sprayed regularly with insecticide and fungicide, and media was added to cover the rood zone at 4 and 8 weeks after transplanting. The watering and insecticide application was stopped 10 days before harvesting.

Results and Discussion.

Growth of Apical Cuttings at Different IAA Concentration

IAA concentration influenced growth of the apical stem cuttings by inlfuencing the number of roots and length of shoot, but it hadno significant effect to number of root. The best treatment was 1 ppm IAA, resulted in the longest root and taller plants with the same number of roots for all treatments (Table 1). All cuttings (1,500 apical cuttings) made in this experiments were rooted succesfully, with number of roots per cutting ranging between 9,4 sampai to 10,6.

Table 1. Length of root, number of roots and length of shoot on apical stem cuttings following treatment with different concentrations of IAA.

IAA Concentration	Length of root (cm)	Number of root	Cutting heigh (cm)
1 ppm	18.6 b*	10.6	11.2 ab
3 ppm	12.1 a	10.2	9.5 a
5 ppm	12.2 a	9.4	12.6 b
HSD 5 %	**3.34**	**-**	**1.52**

*) Values at the same column followed by the same letter/s are not significantly different according to HSD analyses at 5% confidence level

Growth of Apical Cuttings at Different IAA Concentration and Spacing

In general, IAA concentration and planting space had no significant effect on growth and yield of individual G_0 cutting, except that planting space influenced plant height at 3 weeks after transplanting while IAA concentration resulted on different leaf areas at 9 weeks after planting. Taller plant was obtained in lesser planting space (15 cm x 15 cm), and wider leaf area was obtained in cutting treated with 1 ppm IAA (Table 2). In addition, there was also no interaction between the two tretaments on growth and yield of the individual apical cuttings (Table 2 and 3). Each cutting treated with any IAA concentration and planting space produced 3.1 to 3.6 tubers of

27 to 32 g/tuber (considered large size for G_1 tuber) (Table 3). However, planting space altered total yield of G_1 tubers per plot. Different planting spaces gave different number of plant per plot. Lesser planting space resulted in higher number of plant per plot, and thus the highest total yield of G_1 tuber was obtained in planting space of 15 cm x 15 cm (Table 3).

Tabel 2.Height, number of leaf and leaf areas of apical cutting at 3,6 and 9 weeks after transplanting following treatments with dfferent IAA concentrationas and planting space.

Treaments	Cutting Height (cm)			Number of leaves			Leaf area (cm^2)		
	3 wap	6 wap	9 wap	3 wap	6 wap	9 wap	3 wap	6 wap	9 wap
IAA 1 ppm	25,6	27,9	60,7	10,6	36,3	43,0	58,42	67,61	63,0 ab
IAA 3 ppm	27,0	27,9	58.7	11,1	37,6	43,8	63,64	66,51	58,2 b
IAA 5 ppm	26,9	27,5	58.7	10,6	38,0	42,8	64,24	68.50	65,3 a
HSD 5%	-	-	-	-	-	-	-	-	**5,05**
Planting space 15 cm x15 cm	28,4 a	26,6	58.6	10,7	37,4	43,9	58,1	64,2	58,8
Planting space 20 cm x 20 cm	27,4 ab	27,5	58.8	10,5	38,5	43,9	63,1	68,5	65,2
Planting space 25 cm x25 cm	23,7 b	29,4	60,8	11,2	36,1	41,8	64,1	69,9	62,5
HSD 5%	3,8	-	-	-	-	-	-	-	-

*) Values at the same column followed by the same letter/s are not significantly different according to HSD

Table 3. Yield of individual cutting (number of tuber per cutting, fresh weight of tuber per plant, dry weight of tuber per plant, fresh weight of each tuber) and total yield per plot at different IAA concentrations and planting spaces.

Treatments	Number of tuber per cutting	Fresh weight of tuber per cutting (g)	Dry weight of tuber per cutting (g)	Fresh weight of individual tuber (g)	Fresh weight of tuber per plot (g)
IAA 1 ppm	3,3	86,1	13,2	27,7	4329,7
IAA 3 ppm	3,5	94,5	13,4	27,5	4256,9
IAA 5 ppm	3,2	91,7	13,9	29,3	4209,4
HSD 5%	-	-	-	-	-
Planting space 15 cm x15 cm	3,1	77,9	11,2 b	25,7	5841,7 a
Planting spase 20 cm x20 cm	3,6	93,1	13,6 ab	26,7	4095,9 b
Planting space 25 cm x 25 cm	3,4	101,3	15,6 a	32,1	28584 b
BNJ 5%	-	-	**3,42**	-	**1152,31**

*) Values at the same column followed by the same letter/s are not significantly different according to HSD

Overall, the results showed that apical cuttings offered reliable method for the fast propagation of G_0 plant, and thus enhanced yield of G_1 tubers of each G_0 tuber.

Conclusion and Recommedation.

Apical stem cutting can be used as a fast method to propagate G_0 plant and increase the production of G_1 tuber. Growth of the apical cutting was influenced by IAA concentration, and the best IAA concentration for apical stem cutting of G_0 plant of potato was 1 ppm. Different IAA and planting space had similar effect on growth and individual yield of apical cutting, however the highest total yield per plot was obtained in the narrowest planting space of 15 cm x 15 cm.

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