Effect of Growing Media Types with the Addition of PGR and Mung Bean Sprouts Extract on Potato (*Solanum tuberosum* L.) cv. Granola In Vitro Multiplication

Rizal Koen Asharo[1*], *Reni* Indrayanti[1], *Nathania* Nathania[1], *Fani* Setyaningsih[1], *Bunga Al-Mar'Atu* Sholichah[1], *Arin* Nasikah[1], *Farhana Faridah* Achmad[1], and *Karina* Karina[1]

[1]Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Indonesia

Abstract. The use of MS media in potato (*Solanum tuberosum* L.) cv. Granola tissue culture has implications for high prices. Therefore, the use of foliar fertilizer is used as a comparison due to its low price. To increase the growth of potato plants in addition to synthetic plant growth regulators (PGR), extracts of organic matter can be added, one of which is mung bean sprouts extract (MBSE). This study aims to obtain the optimum type of growing medium, the combination of synthetic PGR and MBSE in potato in vitro multiplication. The research methods are (1) in vitro shoot induction and multiplication of potatoes; and (2) in vitro root induction of potato shoots. The results on the parameter number of shoots were obtained 1.75 ± 0.25 for MS media and 2.36 ± 0.34 for synthetic PGR, the number of nodes on the interaction of MS media and synthetic PGR obtained 9.33 ± 1.14, and the number of leaves obtained 2.16±0.27 on MS media. The percentage of live explants obtained was 75.6% for MS media and 22.2% for Growmore media. The highest number of roots in the parameter is 4.15 and the average root length is 3.41 cm.

1 Introduction

Potato (*Solanum tuberosum* L.) belongs to the Solanaceae tribe which has good potential and prospects to support food diversification programs in order to realize sustainable food security with high economic value [1]. In 2019, potatoes were the most imported vegetable commodity, amounting to 132.27 thousand, and were a type of horticultural crop that contained carbohydrates and had high nutritional value [2]. Based on its utilization, potatoes consist of two groups, namely industrial (processed) potatoes and vegetable potatoes [3]. The Central Statistics Agency said that potato production has decreased [4]. This decrease occurred due to the constraints faced by potato farmers in the process of preparing land, planting which is dependent on the climate, and maintaining expensive yields which have an impact on potato prices in Indonesia [5].

* Corresponding author: koenindo@gmail.com

Potatoes in Indonesia experienced fluctuating prices from 2016 to 2018. The price fluctuations that occurred resulted in uncertain profits for farmers as producers. Granola cultivar potatoes include potatoes that experience fluctuating prices so that several uncertain factors arise where the price obtained each harvest season is different depending on the high production costs and the expensive price of certified superior seeds [6,7]. In addition, climate change and unfavorable storage technology lead to lower quality potato seed production [8-11].

Efforts to overcome this can be done through plant propagation by tissue culture (in vitro). Plant propagation by tissue culture is a method used to reproduce, maintain and produce superior traits from superior breeders that are healthy, uniform, have a short time, do not require large areas of land and are independent of climate [12].

The success of tissue culture depends on the media used. One of the most common media is Murashige & Skoog (MS) media. The complex content of MS media which is made from pure chemicals has implications for a relatively more expensive selling price [13]. Therefore, foliar fertilizer is used as a substitute for basic MS media which is relatively cheaper, practical and has almost the same nutrients as MS media.

Foliar fertilizers contain quite complete macro and micro nutrients, one example is Growmore. According to [14], Growmore fertilizer can be applied to vegetable crops such as potatoes. The addition of Growmore foliar fertilizer to potato tissue culture is expected to have the same function as the MS medium used as a comparison. This formula is applied to young plants so that the plants quickly become strong and grow fast.

Potato plant tissue culture functions to increase potato production, it also requires the addition of growth regulators (PGR). Synthetic PGRs that are generally used to regulate the growth and development of explants in vitro are auxins and cytokinins [15]. In addition, Pamungkas (2020) stated that to increase the growth of potato plants, organic matter extracts can be added which are easy to obtain by extracting plant bioactive compounds [16]. Organic materials that can be used as natural growth regulators include green bean sprout extract [17]. Mung bean sprout extract is a potential material as a source of the phytohormone auxin in the form of Indole Acetic Acid [18]. According to research by Mastuti et al (2017), the addition of mung bean sprout extract as much as 3.75% showed the best results based on the number of shoots parameter in ciplukan (*Physalis angulata* L.) solanaceae tribe. Therefore, in this study, natural PGR IAA was used in the form of mung bean sprout extract and Growmore as MS replacement media to observe the growth of Granola cultivar potato plants [19].

2 EXPERIMENTAL DETAILS

This research will be carried out from March 2022 – June 2022 at the Tissue Culture Laboratory, Biology Study Program, Faculty of Mathematics and Natural Sciences, Jakarta State University. The method used is an experimental method using a Completely Randomized Factorial Design (RALF). This design consisted of 2 experiments, namely (1) shoot induction and in vitro multiplication of potato shoots; (2) in vitro induction of potato root shoots.

2.1 Making MS Media and Growmore

Preparation of MS media solution was carried out by dissolving all stock solutions A to F, vitamins, Myo Inositol. Then, PGR solution was added, and 30 grams of sucrose was added. Next, sufficient distilled water is added, and the pH is measured using a pH meter. Media with the appropriate pH was added 7 grams of agar powder and sterile distilled water until the volume reached 1 L and heated to boiling on a hot plate with a magnetic stirrer until

homogeneous. Homogeneous media can be transferred into culture bottles, closed and labeled.

Making Growmore 32-10-10 media by weighing Growmore 2 g/L [14], adding PGR, 30 grams of sucrose, and sufficient distilled water. Furthermore, the methods and materials used are in accordance with the methods and materials used in the manufacture of MS media. All media in capped culture bottles were sterilized using an autoclave at 121°C at a pressure of 15-17 psi, for 15 minutes. Media that has been sterilized is stored in an incubation rack in a culture room with a temperature of 24°C before use.

2.2 Making Mung Bean Sprout Extract

Mung bean sprout extract is made in 2 ways, namely 1) Mung bean seeds are germinated by soaking for 24 hours, then drained and spread on a tray covered with tissue to maintain moisture by sprinkling water as needed and placed in a dark place. 2) Green bean seeds that have germinated for 48 hours are weighed as much as 400 g according to the treatment then mixed with distilled water with a ratio of 1:1 and blended until smooth. 3) filtered using Whatman filter paper to extract the extract and the extract was dissolved in 1 L of water [17].

2.3 Experiment 1: In vitro Shoot Induction and Multiplication of Potato Shoots

In the process of shoot induction and shoot multiplication of the Granola cultivar potato, the first thing to do was the preparation of the media with a combination of treatments in Table 1., tool sterilization, planting, and maintenance. The explants used were node parts derived from potato plantlets. Then, the explants were planted on the treatment medium with sterile tweezers. In each bottle, planted a maximum of 3 pieces of explants. Then maintenance is carried out in the culture room and incubated in a room where the temperature has been set at 18-20°C. The explants were then subcultured once every 4 weeks with three subcultures. Each treatment was repeated 5 times, so that 30 experimental units were obtained. Each experimental unit consisted of 5 culture bottles, each containing three axillary bud explants. Observations were made 1 week after planting (WAP), with the observed parameters being the number of axillary shoots and the number of leaves.

2.4 Experiment 2: In vitro Induction of Potato Shoot Roots

The purpose of this stage of the experiment was to induce and initiate the shoot root extenders formed in experiment 1. The media used was the best media composition which produced the highest number of roots. Observations were made 1 week after planting (WAP), with the observed parameters being the number of plantlets, the number of shoots in one plantlet, and the number of roots.

2.5 Data analysis

The data obtained from all experiments were analyzed statistically using the Two-way Analysis of Variance with a significance degree of 5%, then further tests were carried out using the Duncan Multiple Range Test (DMRT) at the 5% level. Data analysis was performed using the SPSS 24 application program.

3 Results and Discussion

3.1 Induction and multiplication of shoots

3.1.1 Number of shoots

Observation of the number of shoots in this study obtained results at the age of 4 and 7 WAP showing a significant effect on the type of media and PGR, but there was no interaction effect between the two. Based on the results of variance in table 1, it shows that the MS media treatment at 4 WAP gave significantly different results. Meanwhile, at 7 WAP it was found that administration of MS media gave results that were not significantly different.

Table 1. The effect of giving the type of media on the number of shoots on potato plants aged 4 and 7 weeks after planting (WAP)

Media	4 WAP	7 WAP
MS	1.60±0.24a	1.75±0.25a
Growmore	0.90±0.15b	1.36±0.15a

Note: Numbers followed by the same letter in the same column do not differ at the 5% level according to the Independent Sample T-test.

Results on MS media yielded a higher average than Growmore media. This is because MS media contains high nitrogen elements as well as macro and micro nutrients which can support the growth of the number of shoots [20]. In addition, MS media also contains phosphorus which is useful in shoot growth. According to Liferdi (2010), Phosphorus is needed by plants for cell formation in shoot tissue which is in the growth phase [21].

Table 2. Effect of PGR application on the number of shoots on potato plants aged 4 and 7 weeks after planting (WAP)

PGR	4 WAP	7 WAP
BAP 3 ppm + IAA 0.1 ppm	1.86±0.28b	2.36±0.34b
BAP 3 ppm + MBSE 400 g/l	0.98±0.22a	1.61±0.22ab
MBSE 400 g/l	0.90±0.17a	1.30±0.26a

Note: Numbers followed by the same letter in the same column do not differ at the 5% level according to the DMRT test; MBSE: Mung Bean Sprout Extract

The treatment of PGR BAP 3 ppm and IAA 0.1 ppm gave significantly different average results for all treatments at 4 WAP. This treatment also gave an average yield that was significantly different from MBSE 400 g/l (7 WAP). Table 2 shows that the media treatment of 3 ppm BAP and 0.1 ppm IAA was able to produce as many shoots (2.36 ± 0.34).

PGR BAP used in this study can affect the amount of shoot growth, this is supported by the statement of George and Sherrington, (1984), BAP is a PGR group of cytokinins which play a role in the formation and multiplication of shoots and has a stronger effect than other cytokinins such as kinetin or 2-iP. The use of BAP with a concentration of 3 ppm can produce the highest shoots because the cytokinin concentration given is appropriate [22]. This is supported by Andaryani's statement (2010), that shoot growth is determined by the balance that occurs in the administration of exogenous BAP PGR in planting media and endogenous BAP PGR in plants so that the explants will accelerate the process of cell division which produces a large number of shoots [23].

In the study by Maryono et al. (2013) showed that a BAP concentration of 3 ppm in Dendrobium plantlets gave the best results for the number of shoots, number of leaves and plantlet height [24]. The use of this treatment also contains PGR IAA, according to George & Sherington (2008), the use of high concentrations of IAA can inhibit shoot growth. However, in this study IAA was used with a concentration of 0.1 ppm so that it can still be used together with BAP 3 ppm [25]. This is supported by the statement of Sadat et al. (2018) that the use of low auxin concentrations with high cytokinins can result in good shoot formation [26].

3.1.2 Number of nodes

Observation of the number of nodes in this study obtained results at the age of 4 WAP and 7 WAP indicating that there was a real influence on the interaction of media types and PGR on the number of nodes. Based on the results of the variance in table 3, it shows that the administration of 3 ppm MS and BAP media + 0.1 ppm IAA gave significantly different results with all treatments at the age of 4 and 7 WAP. The treatment on the highest number of nodes was on MS and PGR BAP 3 ppm + IAA 0.1 ppm media of 9.33 ± 1.14.

Table 3. The effect of giving PGR media types and combinations on the number of nodes in potato plants aged 4 and 7 weeks after planting (WAP)

Treatment		Mean±SE	
Media	**PGR**	**4 WAP**	**7 WAP**
MS	BAP 3 ppm + IAA 0.1 ppm	7.46 ± 0.44b	9.33 ± 1.14b
	BAP 3 ppm + MBSE 400 g/l	2.90 ± 1.01a	3.60 ± 1.31a
	MBSE 400 g/l	3.73 ± 1.00a	3.86 ± 1.10a
Growmore	BAP 3 ppm + IAA 0.1 ppm	2.50 ± 0.83a	3.30 ± 1.22a
	BAP 3 ppm + MBSE 400 g/l	3.60 ± 0.95a	3.63 ± 0.95a
	MBSE 400 g/l	2.06 ± 0.84a	3.00± 1.29a

Note: Numbers followed by the same letter in the same column do not differ at the 5% level according to the DMRT test; MBSE: Mung Bean Sprout Extract

In this study produced the highest number of nodes on the use of MS media. MS media is a factor that contains complete macro-nutrients, micro-nutrients and vitamins to support the growth of shoots in plants so that it is widely used in tissue culture activities [27, 28]. The increase in the number of nodes was also influenced by the combination of exogenous synthetic PGR given. This results in the success of increasing the number of nodes which is influenced by the right balance between the endogenous hormones in the plant tissue and the administration of exogenous hormones in the media [29, 30].

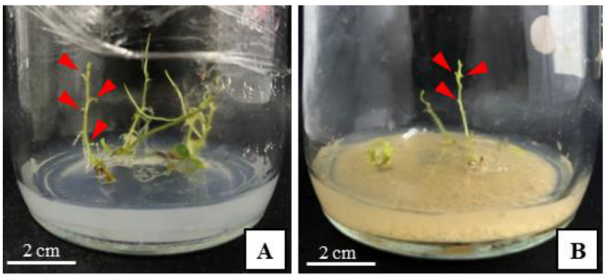

Figure 1. Potato explants aged 7 WAP. A) MS + BAP 3 ppm + IAA 0.1 ppm;B) Growmore + MBSE 400 g/l.

The results of the lowest number of nodes were found in the Growmore media treatment with the addition of MBSE 400 g/l (2.06 ± 0.84) because the mung bean sprout extract given did not show better results (Figure 1). Mung bean sprout extract containing the natural auxin phytohormone type IAA is very labile and easily degrades enzymatically due to the presence of peroxidase enzymes in plants when compared to synthetic auxin which tends to be more active and not easily degraded by enzymes produced in plant tissue cells. So that synthetic PGR can last longer and can be absorbed by plants properly and also in this treatment there is no BAP which can support the growth of shoots and nodes [31, 32].

3.1.3 Number of leaves

Leaves are one of the most important plant organs, especially for photosynthesis so that plants can produce food and experience optimum growth. Observations on the number of leaves in this study were carried out once a week from one week after planting by counting leaves that had completely formed strands (Figure 2).

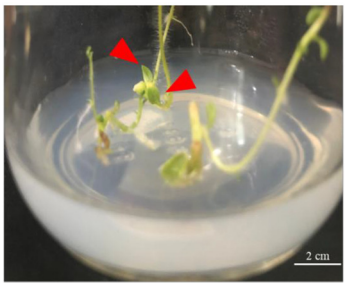

Figure 2. MS potato explant leaves BAP 3 ppm + IAA 0.1 ppm aged 7 WAP

The results of the average number of leaves obtained at 4 WAP showed that the type of media and PGR treatment had no significant effect on the growth of the number of leaves of potato plants. Whereas at 7 WAP the type of media treatment gave a significant difference to the number of leaves. The interaction between the two had no effect on the growth of the number of leaves at the age of 4 and 7 WAP.

Table 4. Effect of giving the type of media and PGR combination on the number of leaves on potato plants aged 4 weeks after planting (WAP)

Basic Media	PGR		
	BAP 3 ppm + IAA 0.1 ppm	**BAP 3 ppm + MBSE 400 g/l**	**MBSE 400 g/l**
MS	2.03 ± 0.18*	1.40 ± 0.48*	1.66 ± 0.54*
Growmore	1.12 ± 0.29*	1.13 ± 0.34*	1.33 ± 0.35*

Note: Numbers followed by the same letter in the same column do not differ at the 5% level according to the MBSE Independent Sample T-test: Mung Bean Sprout Extract.

In table 4 potato explants aged 4 WAP the growth in the number of leaves had no significant effect, this was suspected that the leaves needed time to grow. This is in accordance with the opinion of Purwanto (2009) who said that if young leaves are still growing in explants, these leaves are slower to photosynthesize, and the results obtained are not optimal [33]. In this treatment, the use of cytokinin PGR type BAP which contains nitrogen plays a role in the synthesis of amino acids which are then used for leaf growth [27]. Thus, giving BAP with high concentrations can increase the number of leaves that are more

and more. These results are in accordance with Yatim's research, (2016) which states that the use of MS media with the addition of BAP with a concentration of 3 ppm produces good leaf growth in the multiplication of Raja Bulu bananas (*Musa paradisiaca* L. AAB GROUP) [34]. In addition, there is auxin which plays a role in the process of cell elongation in plant shoots so that it can help increase the number of leaves [35].

Table 5. The effect of giving the type of media on the number of leaves on potato plants aged 7 weeks after planting (WAP)

Media	7 WAP
MS	2.16±0.27a
Growmore	1.35±0.17b

Note: Numbers followed by the same letter in the same column do not differ at the 5% level according to the Independent Sample T-test.

Based on table 5, it shows that MS media gave the highest number of leaves (2.16 ± 0.27) at 7 WAP. It also shows that the treatment using Growmore media produces a lower number of leaves because the N content in Growmore is less than the N content in MS media which is known that nitrogen can function in leaf formation [36]. This is reinforced by the results of Supriati's research, (2010), that Kepok bananas using alternative media (Growmore) produced a lower number of leaves than MS media [37].

3.2 Induction of roots

In this study, only the primary root (main root) was counted and the explants used were the results of experiment 1 which aims to allow the explants to experience growth and development first, then the media used is media that has been modified into MS + BAP 3 ppm + IAA 1 ppm by looking at the results of explants that experienced the best growth. The results obtained on the treatment media showed that the number of roots always increased from 1-8 WAP with the highest average number of roots occurring at the age of 8 WAP of 4.15 (Figure 3).

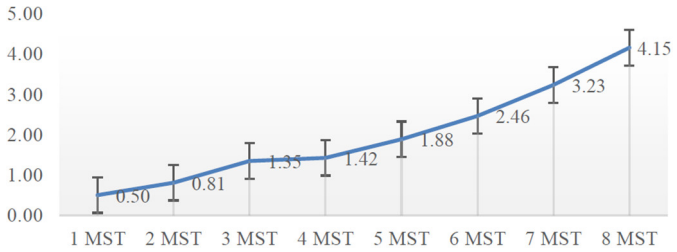

Figure 3. Graph of the number of potato plantlet roots treated with BAP 3 ppm + IAA 1 ppm aged 1-8 WAP.

The treatment combination used was MS media with a combination of 1 ppm PGR IAA which had a lower concentration compared to the 3 ppm PGR BAP concentration used but could produce quite good roots. PGR auxin type IAA plays a role in plant growth and development. The physiological roles of auxin include encouraging cell elongation, cell division, apical dominance, xylem-phloem tissue differentiation and stimulating root formation [38]. While the function of BAP according to Yulia et al. (2020), BAP acts as a shoot former but the use of BAP is not effective for root formation [39]. However, in this study the roots were able to live and develop properly even though the cytokinins BAP were present (Figure 4).

Figure 4. Granola potato plantlet roots at 8 WAP root induction.

This is supported by research from Lathyfah & Dewi, 2016 which showed that the combination of PGR IAA 0.6 ppm and BAP 3 ppm could produce the highest number of roots. In addition, root formation is also inseparable from the process of active tissue division and differentiation which is assisted by the presence of organic and inorganic compounds contained in MS media in the root induction treatment [40].

Measurement of root length was obtained by calculating the length of all plantlet roots that grew in one bottle containing two explants and then averaging it to obtain a root length of 3.41 cm. The results on the number of roots were obtained from 14 bottles of replicates. The highest root length was obtained, which was 5.45 cm. Then for the smallest results obtained, which is equal to 0.75 cm. These results were obtained possibly because the shoots on plantlets have different growth. This is supported by the statement of Pratama et al. (2014) that roots will easily form if the shoots grow perfectly [41]. In addition, the factors that affect root formation are plant growth media such as MS media which have nutrients as factors that influence the pattern of root spread so that they can stimulate root elongation [42].

4 Summary

On the growth of Granola potato plants, the best results were obtained on MS media and synthetic PGR. This is supported by the parameters of the number of shoots obtained in the MS media treatment which produced 1.75 ± 0.25 and synthetic PGR produced 2.36 ± 0.34, the number of nodes on the interaction of MS media and synthetic PGR produced 9.33 ± 1.14, and the number of leaves obtained in MS media treatment yielded 2.16 ± 0.27. The percentage of living explants was found on MS media 75.6% and Growmore media 22.2%. In addition, it is also supported by the parameters of the number of roots 4.15 and root length 3.41 cm. The use of Growmore media cannot provide optimum results on the growth and development of potato plants. This statement is supported by the lowest results obtained for all parameters.

References

1. [CIP] The International Potato Center, *Facts and Figures: 2008–The International Year of the Potato*, http://www.potato2008.org (2008)
2. [BBKP] Balai Besar Karantina Pertanian Belawan, *Kenaikan Ekspor Kentang Sepanjang Masa Pandemi*, http://bbkpbelawan.karantina.pertanian.go.id/ (2020)
3. [BALITSA] Balai Penelitian Tanaman Sayuran, *Kentang Kultivar Granola*. https://balitsa.litbang.pertanian.go.id (2018)
4. [BPS] Badan Pusat Statistik, *Produksi Tanaman Sayuran Kentang (Ton) Tahun 2020 di Indonesia*, Jakarta: BPS-RI (2020)

5. L. M. Kolopaking, *Climate Change Adaptation Strategy of Upland Farmers (Study of Farmers in Dieng Plateau, Banjarnegara Regency)*. Bogor: Institut Pertanian Bogor Sodality: Jurnal Sosiologi Pedesaan, **4**(1), (2016)
6. B. Sayaka, H. Juni, *Kendala Adopsi Benih Bersertifikat Untuk Usaha Tani Kentang*, Forum Penelitian Agro Ekonomi, **29**(1), (2011)
7. W. Wagiono, S. S. Purnomo, S. Abadi, *Keragaan Produktivitas dan Analisis Usaha Tani Kentang Granola Di Kecamatan Pangalengan, Kabupaten Bandung, Pada Masa Pandemi COVID-19*. Jurnal Agrimanex: Agribusiness, Rural Management, and Development Extension, **1**(1), 10–18 (2020)
8. Soegihartono. *Kajian Kepuasan Petani Dalam Penggunaan Benih Kentang Tidak Bersertifikat di Kota Batu Propinsi Jawa Timur*. Bogor: Master Theses from MBIPB (2005)
9. T. Ratnasari, *Kajian Pembelahan Umbi Benih Dan Perendaman Dalam Giberelin Pada Pertumbuhan Dan Hasil Tanaman Kentang (Solanum tuberosum L),* Skripsi, Solo: Universitas Sebelas Maret (2010)
10. B. Sayaka, S. M. Pasaribu, J. Hestina, *Efektivitas Kebijakan Perbenihan Kentang*. Analisis Kebijakan Pertanian, **10**(1), 31-56 (2016)
11. L. Nurhuda, B. Setiawan, D. R. Andriani, *Analisis Manajemen Rantai Pasok Kentang (Solanum Tuberosum L.) di Desa Ngadas, Kecamatan Poncokusumo, Kabupaten Malang*. Malang: Universitas Brawijaya. Jurnal Ekonomi Pertanian dan Agribisnis, **1**(2), 129-142 (2018)
12. R. Dwiyani, *Kultur Jaringan Tanaman*, Pelawa Sari, Bali (2015)
13. H. A. *Putri, Pengaruh Komposisi Media Dasar Dan Kitosan Terhadap Pertumbuhan Protocorm Like Bodies (PLBs) Dan Plantlet Anggrek Phalaenopsis Hibrida*, [Skripsi], Bogor: Institut Pertanian Bogor (2015)
14. A. Nuraini, H. R. Wieny, S. Dewi, *Pemanfaatan Pupuk Daun sebagai Media Alternatif dan Bahan Organik pada Kultur in vitro Kentang (Solanum tuberosum L.) Kultivar Granola*, Prosiding Seminar Nasional Pengembangan Teknologi Pertanian Politeknik Negeri Lampung, 978-602-70530-0-7 (2014)
15. A. K. Karjadi, A. Buchory, *Pengaruh Auksin dan Sitokinin terhadap Pertumbuhan dan Perkembangan Jaringan Meristem Kentang Varietas Granola*, Jurnal Hortikultura, **18**(4), 380-384 (2008)
16. S. S. T. Pamungkas, N. Rudin, *Pengaruh Zat Pengatur Tumbuh Alami Dari Ekstrak Tauge Terhadap Pertumbuhan Pembibitan Budchip Tebu (Saccharum Officinarum L.) Varietas Bululawang (Bl)*, Jurnal Ilmu-ilmu Pertanian, **16**(1), 68 – 80 (2020)
17. A. I. Latunra, Baharuddin, T. Mustika, *Respon Pertumbuhan Propagul Pisang Barangan (Musa acuminata Colla) Dengan Ekstrak Kecambah Kacang Hijau Secara In Vitro*, Prosiding Seminar Nasional from Basic Science to Comprehensive Education (2016)
18. Sujanaatmaja, Ukun, *Pemanfaatan Limbah dan Bahan Alam Hayati untuk Produksi Biostimulantfitohormon Perangsang Pertumbuhan Tanaman Pangan Dan Hortikultura*, Buku, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Padjadjaran, Bandung (2006)
19. R. Mastuti, M. Aminatum, R. Muhfidatur*, The Effect of Tomato Juices and Bean Sprout Extracts on Vitro Shoot Regeneration of Physalis angulata L*, AIP Publishing 8th International Conference on Global Resource Conservation (2017)

20. H. Hariadi, Y. Yusnita, M. Riniarti, D. Hapsoro, *Pengaruh Arang Aktif, Benziladenin, dan Kinetin terhadap Pertumbuhan Tunas Jati Solomon (Tectona Grandis Linn. F) In Vitro*. Jurnal Ilmiah Biologi Eksperimen dan Keanekaragaman Hayati (J-BEKH), **5**(2), 21-30 (2019)
21. L. Liferdi, *Efek Pemberian Fosfor terhadap Pertumbuhan dan Status Hara pada Bibit Manggis*, Jurnal Hortikultura, **20**(1), (2010)
22. E. F. George, P. D. Sherrington, *Plant Propagation by Tissue Culture*, HandBook and Directory of Comercial Laboratories, England: Eastern Press, Reading, Berks, 9-449 (1984)
23. S. Andaryani, *Kajian Penggunaan Berbagai Konsentrasi BAP dan 2,4-D Terhadap Induksi Kalus Jarak Pagar (Jatrop hacuras L.) secara In Vitro*, Skripsi, Universitas Negeri Surakarta, Surakarta (2010)
24. Maryono, M. Yuniawati, L. Harsanti, Pertumbuhan Planlet Galur Mutan Dendrobium jayakarta pada Media VW (Vacin dan Went) dengan Penabahan BAP (Benzyl Amino Purine), *Prosiding Seminar Nasional Sains dan teknologi Nuklir PTNBR ± BATAN*, Bandung (2013)
25. E. F. George, M. A. Hall, G. J. De Klerk, *Plant growth regulators I: Introduction; auxins, their analogues and inhibitors*, In Plant propagation by tissue culture, Springer, Dordrecht, 175-204 (2008)
26. M. S. Sadat, L. A. M. Siregar, H. Setiado, *Pengaruh IAA dan BAP terhadap induksi tunas mikro dari eksplan bonggol pisang kepok (Musa paradisiaca L.)*, Jurnal Agroekoteknologi **6**(1), 107-112, ISSN: 2337- 6597 (2018)
27. F. P. Gardner, R. B. Pearce, R. L. Mitchell, *Physiology of Crop Plants* (Fisiologi Tanaman Budidaya, alih bahasa: Susilo dan Subiyanto), Jakarta: UI Press (1991).
28. M. Silalahi, *Pengaruh Modifikasi Media Murashige-Skoog (MS) Dan Zat Pengatur Tumbuh BAP Terhadap Pertumbuhan Kalus Centella asiatica L. (Urban.)*, Jurnal ProLife, **2**(1), 14-23, ISSN: 2303-0903 (2015)
29. F.W. Lestari, E. Suminar, S. Mubarok, *Pengujian Berbagai Eksplan Kentang (Solanum tuberosum L.) dengan Penggunaan Konsentrasi BAP dan NAA yang Berbeda*, Jurnal Agro, **5**(1), 66- 75 (2018)
30. M. Munggarani, E. Suminar, A.Nuraini, S. Mubarok, *Multiplikasi tunas meriklon kentang pada berbagai jenis dan konsentrasi sitokinin*, Jurnal Agrologia, **7**(2), 80 – 89 (2018)
31. R. Prihatini, *Pemanfaatan air kelapa untuk meningkatkan pertumbuhan akar stek tunas aksilar Andrographis paniculata Nees*, Eksakta: Berkala Ilmiah Bidang Mipa, **18**(2), 62-68 (2017)
32. B.R. Sukmadi*, Aktivitas fitohormon indole-3-acetic acid (IAA) dari beberapa isolat bakteri rizosfer dan endofit*, Jurnal Sains dan Teknologi Indonesia, **14**(3), 221-227 (2013)
33. A. Purwanto, T. Martini, *Krisan Bunga Seribu Warna. Penerbit Kanisius*, Jl. Cempaka 9. Deresan, Yogyakarta, ISBN: 978-979-21-2421-7 (2009)
34. H. Yatim, *Multiplikasi Pisang Raja Bulu (Musa paradisiaca L. AAB GROUP) pada Beberapa Konsentrasi Benzyl Aminopurine (BAP) Secara In Vitro*, Jurnal Agroekoteknologi, (593), 1989 – 1995. ISSN: 2337-6597 (2016)
35. F. Y. Artanti, *Pengaruh Macam Pupuk Organik Cair dan Konsentrasi IAA Terhadap Pertumbuhan Setek Tanaman Stevia (Stevia rebaudiana Bertoni M.)*, Skripsi, Universitas Sebelas Maret (2007)

36. P. S. Batchelor, *Orchid Culture Watering*, Journal Amer Orchid Soc, **50**(8), 945-952 (1981)
37. Y. Supriati, *Efisiensi Mikropropagasi Pisang Kepok Amorang melalui Modifikasi Formula Media dan Temperatur*, Jurnal Agro Biogen, **6**(2), 91-100 (2010)
38. M. Arif, Murniati, Ardian, *Uji Beberapa Zat Pengatur Tumbuh Alami Terhadap Pertumbuhan Bibit Karet (Hevea brasiliensis Muell Arg) Stum Mata Tidur, Jurnal Ilmu Pertanian*, **3**(1), ISS: 2355-6838 (2016)
39. E. Yulia, B. Nurisna, H. Rd Selvy, Nilahayati, *Respon Pemberian Beberapa Konsentrasi BAP dan IAA terhadap Pertumbuhan Sub-Kultur Anggrek Cymbidium (Cymbidium finlaysonianum Lindl.) secara In-Vitro*, Jurnal: Universitas Malikussaleh, Aceh Utara (2020)
40. U. Lathyfah, E. R. S. Dewi, *Pengaruh Variasi Konsentrasi Indole Acetic Acid (IAA) terhadap Pertumbuhan Tunas Pisang Barangan (Musa acuminata L. triploid AAA) dalam Kultur In vitro*, Bioma, **5** (1), 32 – 42 (2016)
41. A. R. Pratama, S. Sugiyono, L. Prayoga, A. Husni, *Upaya Memacu Pertumbuhan Tunas Mikro Kentang Kultivar Granola dengan Jenis dan Konsentrasi Sitokinin Berbeda*, Scripta Biologica, **1**(3), 209-215 (2014)
42. B. Lakitan, *Dasar-Dasar Fisiologi Tumbuhan*, Rajawali Pers, 201, Jakarta, ISBN: 979-421-377-2 (2012)