International Journal of Horticulture, Agriculture and Food Science (IJHAF)
ISSN: 2456-8635
[Vol-6, Issue-6, Nov-Dec, 2022]
Issue DOI: https://dx.doi.org/10.22161/ijhaf.6.6
Article DOI: https://dx.doi.org/10.22161/ijhaf.6.6.4

Growth of Bush Pepper Seedlings of Different Sources of Cuttings Grown on Various Growing Media Formulas

I Ketut Ngawit, Wayan Wangiyana*, Nihla Farida

Faculty of Agriculture, University of Mataram, Mataram, Lombok, Indonesia
*Corresponding author

Received: 20 Nov 2022; Received in revised form: 11 Dec 2022; Accepted: 22 Dec 2022; Available online: 30 Dec 2022

***Abstract*— *Pepper grows creepingly following the growth of its climbing plants, making it difficult to maintain and harvest. Therefore, bush pepper cultivation was developed by replacing climbing trees with 1.5 m high concrete. However, seedlings that can grow into bush pepper are cuttings from fruit branches and primary branches, which are difficult to grow because the nodes of these branches do not have root primordia. This study aimed to obtain cuttings that can grow into bush pepper on the most superior growing media. The experiment was arranged using a completely randomized design (CRD) with two treatment factors, namely formulas of growth media (M1= soil + organic fertilizer + husk; M2= soil + organic fertilizer + compost; M3= soil + organic fertilizer + husk ash; and M4= soil + organic fertilizer + moss) and sources of cuttings (S1= climbing stem; S2= axillary branch; S3= fruit branch; and S4= primary branch with one main stem node). Based on the growth percentage of fruit branches and primary branches in the seedlings, cuttings from climbing stem and axillary branches were not able to grow into bush pepper, because fruit and primary branches only grew less than 5% in all media formulas. Cuttings from fruit branches and primary branches affect the formation of bush pepper with an average percentage of growth of fruit branches and primary branches of more than 95% on M2 and M3 media. Growth of buds, leaves and roots of cuttings from climbing stem and axillary branch was significantly better than cuttings from fruit branches and primary branches.*

***Keywords*— Bush pepper, cuttings, climbing stem, fruit branch, axillary branch.**

I. INTRODUCTION

Pepper (*Piper nigrum* L.) is known as a spice plant, whose fruit is used as a cooking spice, herbal medicine, anti-bacterial and anti-oxidant. Indonesia has made pepper an important export commodity to meet the increasing world demand. In 2016 the world's need for pepper reached 450 thousand tons per year and then increased significantly in 2018 to 578 thousand tons per year. This increase is an opportunity for Indonesia as a pepper producing country. However, Indonesia's contribution as a pepper exporting country is only 20% of the world demand because the area of pepper plantations in Indonesia is only 85,800 ha with an average production of 1.188 tons/ha and national pepper production from 2016 to 2018 only reached an average of 101,981 tons. The low production of pepper in Indonesia is related to the cultivation system used [1, 2].

Pepper is generally cultivated as a climbing plant because the plant grows as climbing vines. Cultivating pepper with climbing plants raises several problems, that the plants grow stretched following the growth of climbing plants, making it more difficult to maintain and harvest because it requires additional labor and equipment [3, 2]. One solution to overcome this problem is to develop bush pepper cultivation. The bush pepper cultivation system does not require climbing trees so it can reduce production costs. In addition, with bush pepper the plant population per hectare can be increased, the production is earlier, and it can be cultivated in multiple cropping systems or intercropping between stands of coconut or other annual crops [4].

The determining factor for the success of a bush pepper cultivation system is the type of seedlings. The seedlings that are commonly used for propagating climbing pepper plants come from climbing vine cuttings while cuttings for bush pepper seedlings come from fruit branch cuttings (plagiotropic shoots). The use of fruit branches as material for cuttings has a major problem because fruit branches do not have primordial roots, making it difficult to grow roots [5]. Therefore, the best source of cuttings for pepper propagation is usually cuttings from climbing vines [6]. However, cuttings from climbing vine will still grow as climbing vine and will not become bush peppers [5].

Another factor that influences the ability to grow pepper cuttings is the growing medium. Application of organic fertilizers and compost to growing media can increase the availability of water for cuttings, and improve media aeration and drainage so that they can stimulate root growth of cuttings [7]. The raw materials for organic fertilizer and compost used are litter from agricultural waste and livestock wastes including cow and egg laying hen manures [8, 9]. However, there is no accurate data and information regarding growing media formulas that can increase the ability of pepper cuttings to grow from fruit branches. Therefore, research has been carried out aimed to obtain pepper bush seedlings from various cutting materials and the best growing media formulas that are suitable for bush pepper nurseries.

II. MATERIALS AND METHODS

This experiment was carried out from March to September 2020 in the greenhouse of the experimental farm of the Faculty of Agriculture, University of Mataram, located in Nyur Lembang Village, Narmada, West Lombok, Indonesia. The materials used were cuttings of the Lampung variety of pepper consisting of primary branch cuttings, fruit branch cuttings, axillary branch cuttings and climbing vine cuttings, which were taken from the main garden in Sai Village, Pupuan District, Tabanan, Bali, Indonesia. Other materials used were “Nutrisoil” solid organic fertilizer, compost, bran, husks, moss, husk ash, NPK fertilizer, Sumialpha 250 EC insecticide and Dithane M-45 fungicide.

The experiment was arranged according to a completely randomized design (CRD) with two factors. The first factor was the formulas of growing medium (M) consisting of 4 levels, namely: M1= soil + organic fertilizer + husk; M2= soil + organic fertilizer + compost; M3 = soil + organic fertilizer + husk ash; and M4 = soil + organic fertilizer + moss. The composition of these ingredients in each media formula is mixed with a volume ratio of 2:1:1. The second factor was the different sources of cuttings (S) consisting of 4 levels, namely: S1 = climbing vine cuttings; S2 = axillary branch cuttings; S3 = fruit branch cuttings; and S4 = primary branch cuttings attached with one node of the main stem. Each treatment combination was made in three replications.

Nursery media were prepared according to the various treatments of media formulas, which were then put into pots with a unit weight of 250 g and poured with water until they reached field capacity conditions. Cuttings consisting of 3 nodes, namely 1 node was planted into the growing media and 2 nodes with two leaves were as the aerial parts of the cuttings. Cuttings that have been planted in these pots were placed on plots and separated according to each treatment as many as 50 pots of cuttings per plot or experimental unit and the placement of the plots was done randomly according to the completely randomized design. Each plot was covered with transparent plastic and the entire plots were covered with black nets to provide 75% shading. During the cutting nursery, the percentage of cuttings growth in each treatment plot was observed until the age of 45 days after planting (DAP) the cuttings. After 45 days in the initial nursery, the cuttings that grew well were transplanted according to each treatment into the growing media for growing the pepper seedlings in large poly-bags with a capacity of 10 liters.

Other observation in the nursery plots were made on the days to bud emergence on the cuttings nodes (days after planting (DAP) the cuttings), the percentage of cuttings grew (%), and the number of buds at 45 HST. To measure the number of roots and root length at 45 DAP, 20% of the total cuttings per plot were uprooted in each plot (or 10 cuttings); then root number and length were measured after cleaning the roots.

In the main experiment using selected growing cuttings transplanted to the large poly-bags, the observation variables included the numbers of fruit branches, primary branches, axillary branches, total number of branches, number of leaves, which were measured every 30 days starting from the day when the seedlings or transplanted cuttings age were 30 days after transplanting (DAT) to large poly-bags until the seedlings were 180 DAT. At this end of the experiment, the fresh and dry weights of the seedlings were also weighed. The data were analyzed with ANOVA and Tukey’s HSD at 5% significance level using CoStat for Windows.

III. RESULTS AND DISCUSSION

Growth of the cuttings

Based on the results of ANOVA (Table 1), there was no interaction effect between the planting media formula and the cutting types on the growing potential of the cuttings. The variety of media formulas only affected the root length of the cuttings but did not affect other cuttings growth parameters. On the other hand, the types of the cuttings affected all parameters of the cuttings' growing potential. The earliest bud emergence occurred in the cuttings from climbing vines and axillary branches, i.e. at 28 DAP and the latest was primary branch cuttings and fruit branch cuttings, i.e. at 38 and 42 DAP, respectively. The highest percentage of growing cuttings occurred in the cuttings from climbing vine (97.70%) and axillary branch cuttings (93.98%). In the treatment of fruit branch cuttings the percentage of cuttings grew was only on average of 14.93% and primary branch cuttings only 14.89%. These data indicate that climbing vine cuttings contain a higher energy source and endogenous growth hormones that can be used to grow shoots and roots compared to other cutting materials.

Cuttings from the climbing vines and axillary branches are thought to be active in the growth process because they are composed of parenchyma tissue with actively dividing cells, so that these cuttings can grow faster and in balance between shoots and roots growth. According to Budi at al. [10], a growth regulator that plays a role in the process of root growth is auxin, while in the process of shoot growth is cytokinin. Balanced auxin and cytokinin levels in cuttings from climbing vines and axillary branches are thought to increase the percentage of cuttings that grow more than cuttings from fruit branches and primary branches. In addition, cuttings of climbing vines and axillary branches do not spend energy on forming flowers and fruit so that the carbohydrate content and growth regulators remain high until the cuttings are planted. According to Djamhuri [11], carbohydrate reserves in plant organs which are the result of balanced respiration and photosynthesis processes, cause the reform process to be less if there is no flowering process. As a result, the plant accumulates more carbohydrate reserves in the stem. Under optimum environmental conditions, carbohydrates will integrate with other building compounds to stimulate the division activity of the meristematic tissue cells at the growing point, which will then grow roots and new buds.

The data in Table 1 reconfirmed that the low carbohydrate content of the cutting materials affected the time of emergence of buds and the percentage of cuttings grew. Therefore cuttings from fruit branches and primary branches had a very low growth percentage of 14.93% and 14.89%. These results are in accordance with the report of Nengsih et al. [12], that the availability of carbohydrates and other supporting compounds greatly influences the growth of shoots and roots of cuttings so that it also affects the percentage of cuttings grew.

The low growing power of fruit branch cuttings and root cuttings is due to the low energy source available to the cuttings. The energy source in the form of carbohydrate reserves has been reduced for flower growth and fruit development, so that when this branch is used as a source of material for cuttings, the growth power is low. The low energy reserves in cuttings of fruit branches and primary branches cause the number of shoots, number of roots and root length to grow less than those grown in cuttings of tendrils and axillary branches. The highest average number of shoots, number of roots and root length occurred in climbing vine cuttings and the lowest in primary branch cuttings. The average number of shoots growing on climbing vine cuttings and axillary branches was 4.75 shoots and 5.58 shoots, significantly different from the number of shoots on cuttings from fruiting branches and planting as many as 2.00 shoots and 1.42 shoots. The number of roots that grew from climbing vine cuttings was 9.42 strands, with an average length of 31.89 cm, while fruit cuttings and root cuttings were only 3.5 - 4.5 strands with an average length of 15.47 cm (Table 1).

Table 1. Effect of different formulas of growing media and sources of cuttings on growth of the pepper cuttings

Treatments	Percentage of cuttings grew (%)	Days to bud emergence	Number of buds	Number of roots	Root length (cm)
M1	55.56 a	33.95 c	3.33 a	6.83 a	20.14 b
M2	55.28 a	33.90 c	3.75 a	6.67 a	27.55 a
M3	55.28 a	34.14 b	3.33 a	6.67 a	27.25 a
M4	55.39 a	34.21 a	3.33 a	6.67 a	19.65 b
HSD 0.05	0.66	0.05	0.64	0.56	0.60
S1	97.70 a	27.78 c	5.58 a	9.42 a	31.90 a
S2	93.98 b	27.60 d	4.75 b	9.33 a	31.74 a

S3	14.93 c	38.41 b	2.00 c	3.58 c	15.48 b
S4	14.89 c	42.42 a	1.42 c	4.50 b	15.47 b
HSD 0.05	0.66	0.05	0.64	0.56	0.60
Interaction	ns	ns	ns	ns	ns

The same letters indicate non-significant different between levels of a treatment factor; ns = non-significant

Roots play a very important role in the growth process of pepper cuttings, because roots determine the growth or death of cuttings. Root growth occurs due to the movement of auxin compounds, carbohydrates and substances that interact with auxin (Rooting cofactor) to the bottom of the cuttings so that they accumulate at the base of the cuttings which then stimulate root growth [10, 13]. The growth of roots on the cuttings is the beginning of the process of absorbing water, anions, cations and other solutes in the soil and then being transferred into plant cells to carry out the process of photosynthesis. The activity of the water absorption process by the roots is influenced by the conditions of the planting medium. This is thought to be the cause of the effect of the planting media formula which appears significant after the roots of the cuttings grow normally and carry out the process of absorbing water and nutrients. The significant effect of this treatment was mainly on the parameter of the root length of the cuttings, namely in the M2 and M3 treatments, the average root length was significantly higher compared with in the M1 and M4 treatments, namely 27.55 cm and 27.25 cm. Meanwhile, the average root length of cuttings in M1 and M4 treatments was only 20.14 cm and 19.65 cm, respectively (Table 1).

Growth of the pepper bush seedlings

The benchmarks for the formation of bush peppers were the growth of fruit branches and primary branches and correction of vine growth after the pepper plants were transferred to the nursery medium. There was an interaction effect between sources of cutting materials and various planting media formulas on branch growth, leaf growth and biomass weight of pepper seedlings. The sources of the cutting materials influences the growth rate of the number of branches, number of leaves, weight of wet and dry seedling biomass, percentage of primary branches and percentage of number of axillary branches, while the types of media formulas did not affect the percentage of growth of primary branches and climbing vines. At the beginning of growth, when the pepper seedlings were 30 DAT, the number of leaves and the number of branches were not significantly different in all treatments, but with increasing age of the seedlings (60 DAT) the effect of each treatment began to be seen. The formula of growng media M2 (soil + organic fertilizer + compost) and M3 (soil + organic fertilizer + husk ash), significantly affected the growth rate of the number of branches and number of leaves. The average value of this parameter was significantly higher than the average parameter value in the treatment of the media formula M1 (soil + organic fertilizer + husk) and M4 (soil + organic fertilizer + moss).

The addition of compost and husk ash to the M2 and M3 media formula resulted in better soil drainage and aeration, so that the availability of N, P, K nutrients and other essential nutrients was thought to be sufficient to support the growth of pepper seedlings. Hendri et al. [14] stated that compost and husk ash as components of the planting media formula were able to increase the content of the N, P and K nutrients as well as micro-nutrients which were needed for plant vegetative growth. Nitrogen plays a major role in the process of forming stems and branches. Potassium is an important supporting element because it is related to its function to increase levels of sclerenchyma which functions to increase the formation of buds on the stems [15]. Many buds caused more young shoots to grow which then grow into branches. Therefore, the number of branches that grew on M2 and M3 media was more than those that grew on M1 and M4 treatments (Table 2).

Table 2. Effect of different formulas of growing media and sources of cuttings on growth of the pepper seedlings

Treatments	Percentage of axillary brances	Percentage of climbing vines	Growth rates of branch number per month	Growth rates of leaf number per month	Seedling fresh weight (g)	Seedling dry weight (g)
M1	55.62 b	54.42 b	0.29 b	1.46 c	28.60 b	11.71 c
M2	56.66 a	57.50 a	0.51 a	2.59 a	80.06 a	39.65 a
M3	56.66 a	57.42 a	0.50 a	2.41 b	79.86 a	37.79 b

M4	55.33 b	53.75 b	0.33 b	1.51 c	29.90 b	12.21 c
HSD 0.05	0.48	0.78	0.04	0.05	12.45	0.80
S1	16.11 b	83.75 a	0.45 a	2.09 a	50.92 a	23.75 c
S2	15.87 b	84.08 a	0.36 b	2.06 a	54.25 a	24.94 b
S3	96.21 a	27.75 b	0.43 a	1.90 b	55.22 a	26.55 a
S4	96.08 a	28.50 b	0.41 a	1.91 b	54.90 a	26.11 a
HSD 0.05	0.48	0.78	0.04	0.05	12.45	0.80
Interaction	ns	ns	s	s	s	s

The same letters indicate non-significant different between levels of a treatment factor; ns= non-significant; s= significant

Leaf growth apparently shows the same trend as branch growth. The availability of sufficient nutrients in the two superior media formulas increased the metabolic activity of the cells which in turn increased the growth rate of the leaf number of the pepper seedlings. Optimum nitrogen and potassium contents as well as micronutrients in cells accelerate the process of formation of nucleic acids, proteins, enzymes and chlorophyll [16]. Under conditions of optimum water availability in the growing media, the metabolic activity will increase so that the division of cells becomes more active, which in turn results in faster growth of stems, branches, leaves and roots [17, 18].

Better growth of pepper seedlings in the two best growing media treatments was also shown by data on the wet and dry biomass weights of the seedlings at 150 DAT. The average weight of fresh biomass and dry biomass of seedlings in the media formula treatment M2 and M3 was significantly higher than the values in the media formula treatment M1 and M4 (Table 2). This result is reconfirmed visually in Figure 1, that the growth of pepper seedlings of the cuttings from fruit branches and primary branches on M2 and M3 growing media was better than on M1 and M4 growing media. In Figure 1, it can also be seen that the number of leaves and the number of branches of seedlings growing on M2 and M3 media was significantly higher than those growing on M1 and M4 media. In these superior media, it was estimated to supply the optimum soil cation exchange capacity (CEC) to supply anions and cations from nitrogen, phosphate, potassium, magnesium, calcium, sulfur, silicate, zinc, iron, and molybdenum compounds to the rhizosphere area to be absorbed by the roots of pepper seedlings.

Furthermore, the vascular tissue transfers these macro and micro nutrients into the cells following a metabolic process based on their respective roles to support the growth of pepper seedlings. Nitrogen is present in various protein compounds, nucleic acids, hormones, chlorophyll and a number of primary and secondary metabolite compounds. Nitrogen is also essential for cell division, cell elongation and cell growth. Phosphate compounds in plant cells act as energy distributors and store energy needed for the growth process. Potassium functions as a transport medium that carries nutrients from roots to leaves and translocates assimilates from leaves to all plant tissues [19, 20].

The advantages of M2 and M3 growing media formulas are able to increase the ability to grow the cuttings from fruit branches and primary branches. As a result, there was an interaction between the growing media formulas and the sources of cutting materials on the growth parameters of pepper seedlings (Figures 2 and 3). The interaction between the two factors occurred due to the influence of fruit branch cuttings (S3) and primary branches (S4) which were positively corrected by the M2 and M3 media formulas, so that the growth of seedlings from the two cutting materials was able to match (not significantly different) the growth of seedlings of the cuttings taken from climbing vines and axillary branches. In conventional growing media, cuttings of fruit branches and primary branches are very difficult to grow roots and buds. However, the M2 and M3 media formulas were able to increase the growing ability of the cuttings taken from fruit branches and primary branches to equalize the growing ability of the cuttings taken from the climbing vines and axillary branches.

Fig1. Growth of the fruit branch cuttings on all types of the growing media (M1, M2, M3 and M4)

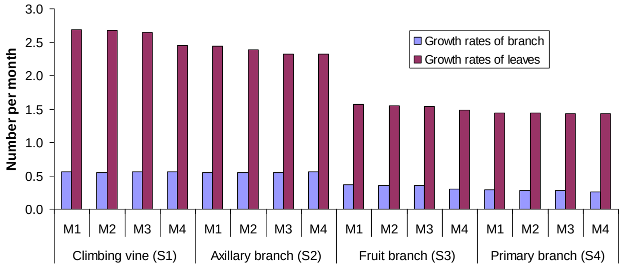

Fig2. The interaction effects between formulas of growing media and sources of cuttings on the growth rate of branch number and growth rate of leaf number of the pepper seedlings.

Fig 3.The interaction effects between the formulas of growing media and sources of cuttings on the weight of fresh and dry weight of the pepper seedlings

In Table 2, it can be seen that cuttings taken from fruit branches (S3) and primary branches (S4) have the potential to grow into bush peppers because the growing percentage of tertiary branches was significantly higher, namely 96.21% (S3) and 96.08% (S4), while in the cuttings taken from climbing vines (S1) and axillary branches (S2) the growing percentage of tertiary branches was only 16.51% and 15.27%, respectively, so they had no potential to produce bush pepper. This data are reconfirmed physically in Figure 4, that pepper seedlings taken from climbing vines grow more climbing vines and axillary branches, so they cannot grow into bush pepper.

Fig.4. Seedlings from cuttings taken from the climbing vine (S1) and axillary branches (S2) grow into climbing shoot and axillary branches so they cannot grow into bush pepper

IV. CONCLUSION

The cuttings taken from climbing vines and axillary branches had better growing ability than those taken from fruit branches and primary branches. The formula of the growing media did not affect the growing ability of the cuttings, but did affect the growth of seedlings from cuttings taken from fruit branches and primary branches. Cuttings from fruit branches and primary branches have the potential to produce bush pepper because the growing percentage of tertiary branches was 96.08 - 96.21%, while cuttings taken from climbing vines and axillary branches did not have the potential to produce bush pepper because the growing percentage of tertiary branches was only 15.27 - 16.51%. Seedlings from cuttings of fruit branches and primary branches were able to grow well and equalized the growth of seedlings from cuttings of climbing vines and axillary branches on the soil + organic fertilizer + compost growing media formula. It is recommended to make bush pepper seedlings using cuttings taken from fruit branches and primary branches with growing media mixed with soil + organic fertilizer + compost (2:1:1 v/v/v).

ACKNOWLEDGEMENTS

We would like to thank the Rector and Chairman of the Institute for Research and Community Service of the University of Mataram for the "PNBP" research grant provided for conducting this study under the 2021 budget year.

REFERENCES

[1] Meilawati N.L.W., N Bermawie, A. Parwito, and D. Manohara, 2016. Respon Tanaman Lada (*Piper nigrim* L.) Varietas Ciinten terhadap Iradiasi Sinar Gamma. *Jurnal Litri*. 22(2): 71 80..

[2] Kardinan A., I Wayan Laba dan Rismayani, 2018. Peningkatan Daya Saing Lada (*Piper nigrim* L.) Melalui Budidaya Organik. *Jurnal Perspektif*. 17 (1): 26-39.

[3] Yuliana, E. Rahmadani, dan I. Permanasari. 2015. Aplikasi Pupuk Kandang Sapi dan Ayam Terhadap Pertumbuhan dan Hasil Tanaman Jahe (*Zingiber officinale* Rosc.) di Media Gambut. *Jurnal Agroteknologi.* 5(2):37-42.

[4] Yuhono, J.T. 2007. Sistem Agribisnis Lada dan Strategi Pengembangannya. *Jurnal Libang Pertanian*. 26(2): 76-81.

[5] Ravindran, P.N., Babu, K.N., Sasikumar, B. and Krishnamurthy, K.S. 2000. Botany and Crop Improvement of Black Pepper. p. 23-142. In: Ravindran, P.N. (Ed), Black Pepper (*Piper nigrum* L). Harwood Academic Press, The Netherlands: Amsterdam.

[6] Nengsih, Y., Marpaung, R. dan Alkori, 2016. Sulur Panjat Merupakan Sumber Stek Terbaik untuk Perbanyakan Bibit

Lada Secara Vegetatif. Jurnal Media Pertanian. 1(1) : 29-35. DOI: http://dx.doi.org/10.33087/jagro.v1i1.13

[7] Keymer, D.P. and R.A. Lankau, 2017. Disruption of plant-soil-microbial relationship influences plant growth. Journal of Ecology. 105(3): 816-827.

[8] Sulok, K.M.T., Ahmed, O.H., Khew, C.Y. and Zehnder, J.A.M., 2018. Introducing natural farming in black pepper (*Piper nigrum* L.) cultivation. International Journal of Agronomy, 2018, DOI: https://doi.org/10.1155/2018/9312537

[9] Ngawit I Ketut, I Gde Ekaputra Gunartha dan Ni Made Laksmi Ernawati, 2018. Uji Potensi Pupuk Organik Hasil Pengolahan Gulma Lunak Melalui Proses Dekomposisi Kedap Udara terhadap Status Kesuburan Tanah dan Hasil beberapa Tanaman Semusim dalam Sistem Pola Tanam Bergilir. Prosiding Seminar Nasional Saintek Lombok, 2018. p. 423 – 436. https://lppm.unram.ac.id/prosiding-seminar-saintek-2018/

[10] Budi, M.A.I Donowati dan Dianto, 2012. Pengaruh Kencing Sapi dan Air Kelapa Muda pada Pertumbuhan Stek Lada (*Piper nigrum* L.). Jurnal Java Primordial. 8 (1): 223-234.

[11] Djamhuri E., 2011. Pemanfaatan Air Kelapa untuk Meningkatkan Pertumbuhan Stek Pucuk Meranti Tembaga (*Shorea leprasula* Miq.). Jurnal Silvikultur Tropika. 2(1) : 8220-8227.

[12] Nengsih, Y., Marpaung, R. dan Alkori, 2016. Sulur Panjat Merupakan Sumber Stek Terbaik untuk Perbanyakan Bibit Lada Secara Vegetatif. Jurnal Media Pertanian. 1(1): 29-35. DOI: http://dx.doi.org/10.33087/jagro.v1i1.13.

[13] Ulfa, M., Marlina dan Mariana, 2017. Respon Pertumbuhan Stek Lada (*Piper nigrim* L.) Akibat Pemberian Hormon Auksin. Jurnal Agrotropika Hayati. 4 (4) : 332-341.

[14] Hendri, M., M. Napitupulu dan A.P. Sujalu, 2015. Pengaruh Pupuk Kandang Sapid an NPK Mutiara Terhadap Pertumbuhan dan Hasil Terong Ungu (*Solanum melongena L.*). Jurnal Agrifor. 14(2): 213-221.

[15] Dwiati, M. 2016. Peran Zat Pengatur Tumbuh Auksin dan Sitokinin terhadap Pertumbuhan Semai Anggrek *Phaleanopsis.* Makalah disampaikan dalam acara Pelatihan Budidaya Anggrek di PKH Banten, Subang, Banyumas. p.7.

[16] Pradana, G.B.S., T. Islami, dan N.E. Suminarti.2015. Kajian Kombinasi Pupuk Fosfor dan Kalium pada Pertumbuhan dan Hasil Dua Varietas Tanaman Sorgum (*Sorghum bicolor* (L.) Moench.). Jurnal Produksi Tanaman. 3 (6): 464-471.

[17] Yusrianti. 2012. Pengaruh Pupuk Kandang dan Kadar Air Tanah Terhadap Produksi Selada (*Lactuca sativa* L). *Skripsi.* Fakultas Pertanian, Universitas Riau, Riau.

[18] Alhrout, H. 2017. Response of Yield and Growth Component of Sweet Pepper to Tow Different Kinds of Fertilizer Under Green House Condition in Jordan. Journal of Agriculture Science. 9(10): 265-272. DOI: 10.5539/jas.v9n10p265.

[19] Silahooy, Ch. 2008. Efek Pupuk KCl dan SP-36 terhadap Kalum Tersedia, Serapan Kalium dan Hasil Kacang Tanah (*Arachis hypogaea L.*) pada Tanah Brunizem. Buletin Agronomi. 36(2): 126-232.

[20] Wijayanti, E. 2013. Pengaruh Pemberian Pupuk Kotoran Ayam dan Kotoran Kambing Terhadap Produktivitas Cabai Rawit (*Capsicum frustescens* L.). *Skripsi.* Universitas Muhamadyah Surakarta, Surakarta.