Agronomy Research **20**(S1), 1175–1186, 2022
https://doi.org/10.15159/AR.22.061

Enrichment of growing media using biochar, compost, and nanosilica for the cultivation of *Oryza sativa* L.

E. Widiasri[1], R.R. Maulani[1], D. Nofitasari[1], K. Lambangsari[1], R. Manurung[1] and M.Y. Abduh[1,2,*]

[1]School of Life Sciences and Technology, Institut Teknologi Bandung, Jalan Ganesha 10, ID40132 Bandung, Indonesia
[2]University Center of Excellence for Nutraceuticals, Bioscience and Biotechnology Research Center, Institut Teknologi Bandung, Jalan Ganesha 10, ID40132 Bandung, Indonesia
[*]Correspondence: yusuf@sith.itb.ac.id

Received: August 1st, 2022; Accepted: September 12th, 2022; Published: September 12th, 2022

Abstract. This study investigated the effect of growing media composition on the growth and productivity of *Oryza sativa* var. Inpago 7 cultivated in polybags at Sumedang, West Java, Indonesia, for 126 days. A randomized block design was applied with nine combinations of growing media. Each treatment consisted of five polybags and was replicated three times. Plant height, number of leaves, and tillers were measured at 15, 30, and 45 days after transplanting to observe the growth parameters. While, for estimation of productivity were recorded the weight of dry grain harvest (DGH), the weight of dry milled grain (DMG), and the weight of 100 grains (g) were recorded for each treatment for estimation of productivity. The results showed that the highest number of panicles (24 panicles per plant), the weight of dry harvested grain (21.74 g per plant), and weight of dry milled grain (17.83 g per plant) were obtained when cultivated with a growing medium containing soil, biochar, synthetic fertilizer, urea and sprayed with nano-silica. The growing media composition did not influence the weight of 100 grains because it is more influenced by genetic characteristics. An appropriate combination of soil, biochar, synthetic fertilizer, urea, and sprayed with nano-silica is recommended as a growing media for cultivating *O. sativa* L. var. Inpago 7.

Key words: biochar, growing media, nanosilica, *Oryza sativa*.

INTRODUCTION

Rice (*O. sativa* L.) is a major and important crop in Asia as well as in Southern Europe and The United States of America (Nair, 2019) with a global annual productivity of 518 tons (Vijayakumar et al., 2005). The Food and Agricultural Organization suggested that by the year 2025, the world population (about 8.5×10^9 people), will require substantial enhancement in agricultural production to satisfy the demand (Singh et al., 2018). As the population grows, the need for rice continues to increase, while the amount of arable land for cultivation crops is limited (Pratiwi et al., 2020). Rice is produced from approximately 8.1 million ha of land in Indonesia in 2013. Sustainable management of that land for rice production is very crucial to meet national rice demand

(Purwanto et al., 2017). Recently, the main problems of tropical agricultural soils are the depletion of soil fertility and the decline in the productivity of agriculture crop due to the reducing of organic matter and imbalances nutrients inside the soil (Agegnehu et al., 2017). One of the factors that determine the productivity and physiological growth of *O. sativa* L. is the growing medium. Various studies have been carried out to investigate the effect of different growing media on the growth and yield of different plants (Manh & Wang, 2104; Mehmood et al., 2017). The substrate or a combination of substrates used to grow seedlings is important to provide plants with mechanical supports, water, and mineral for their growth and development (Radha et al., 2018). The application of growing media either in excess or less than optimum dose affects both yield and quality of the harvested rice. Hence proper management of crop nutrition, particularly the composition of the growing medium, is of immense importance to optimize plant growth and meets nutritional needs (Tubana et al., 2016).

Over the past decades, many studies have been carried out to replace the soil in a growing media with superior quality, inexpensive, readily available, and environmentally friendly substrates (Kather, 2015; Tubana et al., 2016; Radha et al., 2018). Biochar is a carbon-rich material that has been considered as a promising alternative as a replacement of soil as a growing medium (Novák et al., 2020). Biochar is a soil conditioner produced from the thermal decomposition of organic materials through pyrolysis, and it has the potential to increase crop yields. It can improve plant growth and soil quality. The advantage of biochar addition on cultivation process were attributed to improved soil properties, such as decrease in soil bulk density, and subsequent increase in porosity and water holding capacity, increase in the cation exchange capacity which enhances the retention of basic nutrients, increased uptake of N and its availability in soil, adsorption of soil phytotoxins, liming effects, and increased plant nutrient concentration (Wacal et al., 2019). Nemati et al. reported that biochar increases pH and decreasing nutrient leaching up to 11% (Nemati et al., 2015). The study also highlighted that biochar is a good alternative for replacing perlite and peat moss in the growing medium. In another study conducted by Parr, biochar also serves as nutrient retention whose can improve the accessibility of nutrients into plants (Parr & Sullvian, 2015).

In addition to biochar, compost has been widely used as a soil conditioner because it contains a high organic matter and possesses physical and chemical properties that can improve the fertility and aggregate structure of the soil (Wasis & Fathia, 2010; Khater, 2015). Application of biochar to nutrient poor soils could be one of the potential options to enhance agriculture productivity (Xu et al., 2017). The plant residue biochar, an alternative organic supplement to chemical fertilizers, could be viable and sustainable way to enhance crop yield (Agegnehu et al., 2017). The use of biochar in agriculture can enhance agriculture soil fertility, adverse impact of chemicalization on soil fertility (Kim et al., 2017), soil microbial biodiversity (Luo et al., 2017), and agriculture productivity (Agegnehu et al., 2017).

Khater (2015) has investigated compost's physical and chemical properties produced from cattle manure, herbal plant residues, and sugar cane residue (Kather et al., 2015). The total organic matter in the compost varies from 28.6 to 41.2%, with a carbon to nitrogen ratio of 14.2:1 to 18.5:1 that lies in the ideal range of ready to use compost for growing plants (Rosen et al., 1993). According to Gab (2014) and Ramos (2017), compost can improve the structure of soil than decreases crust formation, surface runoff, and erosion. The application of compost increases porosity, water retention, and hydraulic conductivity of the soil.

Silica is a non-essential nutrient that is very beneficial for plants to hold water in a dry environment, bind other nutrients so that the nutrient content in the soil is not lost, and water reserves will be maintained its quantity. The supply of Si can provide a good crop yield because it can increase cell strength and endurance. Si makes leaves more erect in the effect of high nitrogen fertilization to increase photosynthesis. It plays a role in increasing growth, increasing photosynthesis, transpiration efficiency and evaporation, increasing leaf strength, chlorophyll concentrations per leaf area and product quality. The use of nano-silica will make fertilizers more easily absorbed by plants and more efficient than conventional chemical fertilizers (Prihastanti et al., 2018).

This study was carried out to investigate the potential application of biochar and compost as constituents of the growing medium used to cultivate rice. Biochar and compost were mixed with soil at pre-determined compositions and added with nano-silica to promote plant growth and increase plant turgidity. Optimum composition and appropriate dose of the growing medium is of economic importance to increase plant productivity and farmers' income. Hence, this study aimed to determine the effect of variations in the growing medium composition using biochar, compost, and nano-silica on the growth and productivity of *O. sativa* var. Inpago 7.

MATERIALS AND METHODS

Materials

The seeds of *O. sativa* var. Inpago 7 was purchased from Indonesian Center for Rice Research, Sukamandi, West Java. The growing media used in this study consisted of ultisol soil (0.20% nitrogen; 0.061% phosphorus; 1.29% potassium; 0.003% silicon monoxide), leaf compost (0.79% nitrogen; 2.56% phosphorus; 0.023% potassium; 0.0004% silicon monoxide), biochar (0.69% nitrogen; 0.035% phosphorus; 0.10% potassium; 0.11% silicon monoxide), liquid nano-silica (1.3% silicon dioxide) (brand name: Tenaz), synthetic fertilizer from (15% nitrogen:15% phosphorus:15 % potassium) (brand name: Mutiara), and urea (45% nitrogen).

Cultivation of *O. sativa* var. Inpago 7

O. sativa L. var. Inpago 7 was cultivated using polybags (diameter: 30 cm, height: 40 cm) in a screen house at Institut Teknologi Bandung - Jatinangor Campus, Sumedang, West Java, Indonesia with an 5 of 27–29 °C, relative humidity of 72–75% and wind speed of 0.4–0.6 m s^{-1}. A randomized block design was applied in this study with nine different treatments on the composition of the growing media, as shown in Table 1 where the composition for T8 is typically

Table 1. Composition of the growing media used for the cultivation of *O. sativa* var. Inpago 7

Code	Composition
T1	Soil: biochar: compost (2: 1: 1) + nano-silica
T2	Soil: biochar (2: 2) + synthetic fertilizer + urea + nano-silica
T3	Soil: biochar (2: 2) + nano-silica
T4	Soil: compost (2: 2) + sprayed nano-silica
T5	Soil + synthetic fertilizer + urea + sprayed nano-silica
T6	Soil: biochar (2: 2) + sprayed nano-silica
T7	Soil: compost (2: 2)
T8	Soil + synthetic fertilizer + urea
T9	Soil: biochar (2: 2)

applied by farmers in the studied location, hence considered as the control in this study. Each treatment consisted of five pieces of polybags containing two seeds. Every treatment was replicated three times, and the average values were reported. Initially, the seeds were germinated on wet damp-sack, and the growing medium was mixed according to the composition shown in Table 1 before being placed inside the polybags.

After the seeds had germinated, the seeds were sown using trays until the leaf reached a size of ± 10 cm, then transplanted into polybags that have been filled with the growing media. Every plant was provided with 2.7 g of synthetic fertilizer (equivalent to 300 kg ha^{-1}), 1.35 g of urea (equivalent to 150 kg ha^{-1}), and 2.7 mL of nano-silica (equivalent to 2 L ha^{-1}). The plants were watered once a day as suggested by the System Rice Intensification method (Thakur et al., 2010; Widiasri et al., 2021). The growth performance of *O. sativa* L. var. Inpago 7 were measured at 15, 30, and 45 days after transplanting (DAT). The parameters of growth of performance were plant height, number of leaves, and number of tillers. A meter ruler was utilized to measure the height of plant starting from the bottom of the shoot which is located at the surface of the soil until the end of the tallest leaf in the plant's foliage (Mensah & Frimpong, 2018). The number of leaves and tillers of the *O. sativa* L. var. Inpago 7 were counted manually (Japakumar et al., 2021). The biomass was harvested after 126 days by cutting the panicles containing grain. The weight of dry grain harvest (DGH), the weight of dry milled grain (DMG), and the weight of 100 grains (g) were recorded for each treatment for estimation of productivity.

Statistical analysis

The software that was utilized to carry out the statistical analysis for this study is IBM SPSS. Statistical analysis was conducted using Analysis of Variance ($\alpha = 0.05$) and Duncan's Multiple Range Test ($\alpha = 0.05$) to compare the differences between the average values of each treatment.

RESULTS AND DISCUSSION

Effects of growing media composition on plant growth

Height of the plant, number of leaves, and number of tillers were recorded periodically, and the results are shown in Table 2–4. Plant height is an indicator of plant growth and an important agronomic trait directly related to the harvest index and yield potential. The total number of elongated internodes and the length of each elongated internodes determine plant height with paddy usually has 4–6 elongated internodes (Zhang et al., 2009; Zhong et al., 2020). Table 2 shows that variations in the growing media composition have significant effects on plant height.

After 15 and 30 days of transplanting, T1 and T5 gave better effects on the average plant height than the control (T8) and other compositions, whereas, after 45 days of transplanting, rice grown in T2, T5, and T7 reached its highest average height at the end of the vegetative period: 59.72 cm, 57.69 cm, and 57.94 cm, respectively. The increase in plant height was in line with the abundant amount of nitrogen element in the media because the plants were supplied with synthetic fertilizer and urea, which results in an increase in vegetative growth with more nitrogen supply to the plants. The plant height recorded in this study lies in the range of plant height of 55 to 79 cm for *O. sativa* L var.

Ciherang cultivated at the same location as reported by Widiasri et al. (2021).

The average number of leaves for each treatment after 15, 30, and 45 days of transplanting are presented in Table 3. Leaves are the most noticeable parts of a plant; they are the predominant photosynthetic organs and pivotal for carbon fixation (Even, 2018). Some leaf parameters, such as shape, number, size, thickness, direction, and chloroplast level, are very important factors influencing a plant's biomass formation and success. Variation in the growing media composition at the beginning phase had no significant effects on the number of leaves. The effect of began to appear at 30 and 45 days of transplanting. Even though the effect was not significantly different for T4, T5, and T7 after 30 days of transplanting as well as T1, T4, T5, and T8 after 45 days of transplanting, the number of leaves increased for T2 after 45 days of transplanting as compared to the control (T8).

Table 2. Effect of growing media composition on the plant height of *O. sativa* var. Inpago 7

Treatment	Plant height (cm)		
	15 days	30 days	45 days
T1	30.01^{a}	38.61^{ab}	49.46^{ab}
T2	39.43^{c}	51.70^{e}	59.72^{c}
T3	30.56^{ab}	36.09^{a}	46.42^{a}
T4	32.89^{ab}	41.81^{abc}	55.12^{abc}
T5	40.21^{c}	48.68^{de}	57.69^{bc}
T6	30.96^{ab}	38.28^{ab}	48.56^{a}
T7	33.60^{ab}	44.31^{cd}	57.94^{bc}
T8	34.72^{b}	43.51^{bcd}	54.33^{abc}
T9	30.38^{ab}	36.31^{a}	47.32^{a}

*The average number followed by superscript of the same letter in each column is not significantly different based on *Duncan's Multiple Range Test* (a = 0.05).

Table 3. Effect of growing media composition on the number of leaves of *O. sativa* var. Inpago7

Treatment	Number of leaves		
	15 days	30 days	45 days
T1	4.40^{a}	10.37^{ab}	37.13^{abc}
T2	11.77^{a}	31.47^{c}	73.27^{e}
T3	3.70^{a}	8.47^{a}	23.13^{a}
T4	6.67^{a}	20.77^{abc}	42.11^{bcd}
T5	6.77^{a}	22.63^{bc}	48.50^{cd}
T6	6.17^{a}	12.10^{ab}	28.54^{ab}
T7	6.80^{a}	22.40^{bc}	55.47^{d}
T8	5.80^{a}	15.83^{ab}	35.70^{abc}
T9	5.43^{a}	13.60^{ab}	23.54^{a}

*The average number followed by superscript of the same letter in each column is not significantly different based on *Duncan's Multiple Range Test* (a = 0.05).

Table 4. Effect of growing media composition on the number of tillers of O. sativa var. Inpago 7

Treatment	Number of leaves		
	15 days	30 days	45 days
T1	1.77^{a}	4.97^{ab}	14.71^{bcd}
T2	4.93^{a}	14.63^{c}	23.03^{e}
T3	1.20^{a}	3.50^{a}	7.97^{a}
T4	2.43^{a}	8.77^{ab}	17.60^{cd}
T5	3.00^{a}	9.83^{b}	16.84^{cd}
T6	2.13^{a}	5.03^{ab}	9.79^{ab}
T7	2.63^{a}	9.30^{b}	18.78^{de}
T8	2.37^{a}	7.09^{ab}	12.59^{abc}
T9	2.27^{a}	5.83^{ab}	8.95^{a}

*The average number followed by superscript of the same letter in each column is not significantly different based on *Duncan's Multiple Range Test* (a = 0.05).

The effect of growing medium composition on the number of tillers is shown in Table 4. After 15 days of transplanting, the growing media compositions had no significant effects on the number of tillers. The formation of new tillers started after 25 days of transplanting. Plants from T2 had a higher number of tillers with an average of 23 tillers after 45 days after being planted compared to the control (T8) and other treatments. As such may be attributed to more nitrogen supply to the plants during the active tillering stage. Previous studies have demonstrated that the application of nitrogen significantly increased the number of effective tillers and uptake of nitrogen by

O. sativa L up to the level of 200 kg of nitrogen per hectare (Meena et al., 2002; Meena et al., 2003).

Based on the results obtained in this study, T2 (soil: biochar (2:2) + synthetic fertilizer + urea + nano-silica) is the combination of growing media that produces the best growth of *O. sativa* L. with a plant height of 59.72 cm, 73 leaves, and 23 tillers. The presence of synthetic fertilizer and urea in the growing media at the beginning of the cultivation period is very important to promote plant growth because synthetic fertilizer and urea can be easily absorbed by the plants as essential nutrients (Leghari et al., 2016, Radchenko et al., 2021). Synthetic fertilizer is part of the essential nutrients needed for meristematic and physiological activities such as leaf formation, roots, as, dry matter production, and others, leading to efficient water translocation and nutrition, interception of solar radiation, and carbon dioxide. This can improve the process of larger photosynthesis from adequate assimilation to subsequent translocation to various channels (Jaliya et al., 2008).

Nitrogen is a constituent of amino acids and chlorophyll that is vital to accelerate plant height, phosphorus acts as a storage and transfer of energy for the entire metabolism that leads to the formation of roots in plants, and potassium acts as an enzyme activator to assists transport of assimilated products from the leaves to the entire plant tissue (Leghari et al., 2016). The addition of compost in the growing media had no significant effects at the beginning of the plant growth because the compost generally has a low concentration of nitrogen, phosphorus, and potassium as well as macro and micronutrients in comparison to commercial fertilizer (Kather, 2015). Compost provides a better effect as s soil conditioner because of its ability to retain water and improve the aggregate of soil as well increase the biological activity of soil (Manh & Wang, 2014, Kather, 2015).

The provision of biochar in a growing media positively affected growing plant due to the increased nutrition available to the plants. The silica content in biochar could increase plant growth especially the growth of stems and tillers. The number of tillers was influenced by the availability of nutrients in the soil, and the growth of tillers was strongly influenced by nitrogen, especially in the initial phase. Hence, the addition of biochar in the growing media improve soil quality to promote a better plant growth particularly the root and shoot (Liu et al., 2017; Pratiwi et al., 2020). The addition of biochar could increase the resistance of nitrogen element by preventing nitrate discharges which can increase soil nitrification thereby increasing the availability of nitrogen for the plants (Darusman et al., 2017).

The presence of nano-silica in the growing media had significant effects on plant growth. Provision of nano silica fertilizer by sprinkling to the leaves aims can lead to better absorption by the plants for optimum growth (Prihastanti et al., 2018). The plant cell wall acts as a barrier to insert foreign agents into plant cells. The nanoparticles having a smaller diameter compared with the pore diameter of cell wall can easily pass through the pores of the walls. The nanoparticles on the leaf surface enter the plant through the pores or villus base and then transported to different tissues (Nair et al., 2010). Silica plays a role in increasing growth, increasing photosynthesis, transpiration efficiency, and evaporation, increasing leaf strength, chlorophyll concentration per leaf area and product quality (Hwang et al., 2005). When silica is reduced, the amount of chlorophyll will decrease and consequently the photosynthesis of plants will decrease.

In addition, silica also has a role in the chain of photosynthesis and prevents chlorophyll degradation (Lawlor et al., 2002).

Previous studies have shown that nano-silica positively influences the structure and biosynthesis of cell walls for grassy plants and increases plant height significantly (Marxen & Klotzbucher, 2016). In addition, nano-silica also plays a role in the process of leaf formation, as demonstrated by Marxen & Klotzbucher, 2016). Silica also plays an important role in the upright leaf state and can provide more areas of leaves to light, thereby increasing the efficiency of plant photosynthesis. Silica makes leaves more erect in the effect of high nitrogen fertilization to increase photosynthesis. Sufficient use of silica may reduce the likelihood of wilting plants under drought conditions due to decreased permeability of water vapor from leaf epidermal cell walls. It also affects phosphorus fixation so that its availability increases (Prihastanti et al., 2018).

Effects of growing media composition on biomass productivity

After 100 days of cultivation, the plants were harvested, and the biomass productivity was determined in terms of the number of panicles, the weight of dry harvested grain (DHG) per plant, the weight of dry milled grain (DMG) per plant, and the weight of 100 grains (Table 5). The highest number of panicles (24 panicles per plant), the weight of DHG (21.74 g), and weight of DMG (17.83 g) were obtained when the plants were cultivated with a growing medium containing soil, biochar, synthetic fertilizer, urea, and nano-silica (T2) that also produced the highest number of tillers during the growth period as compared to the control (T8) and other treatments. The panicles were produced by productive tillers that possess flag leaves, indicating that the generative growth had begun. The significant increase in the number of panicles per plant with biochar treatments could be increase the weight of DHG and weight of DMG per plant. The results in this study indicate that application of biochar and nano silica have a capacity to increase plant development, water, and nutrients absorption, and subsequently maximize yield-related traits and productivity (Hafez et al., 2021).

Table 5. Effects of growing media composition on the average number of panicles, weight of dry grain harvested, weight of dry milled grain, and weight of 100 grains of *O. sativa* L. var Inpago 7 after 100 days of transplanting

Treatment	Number of panicles per plant	Weight of DHG per plant (g)	Weight of DMG per plant (g)	Weight of 100 grains (g)
T1	21.32^{bc}	15.04^{abc}	11.48^{abc}	2.23^{a}
T2	24.07^{c}	21.74^{c}	17.83^{c}	2.17^{a}
T3	9.20^{a}	5.86^{a}	4.35^{a}	2.29^{a}
T4	$20.47b^{c}$	11.22^{ab}	8.59^{ab}	1.54^{a}
T5	$19.40b^{c}$	13.64^{abc}	10.85^{abc}	2.31^{a}
T6	11.47^{a}	7.59^{a}	5.68^{a}	2.13^{a}
T7	22.67^{c}	20.04^{bc}	15.75^{bc}	2.22^{a}
T8	15.33^{ab}	14.53^{abc}	11.19^{abc}	2.28^{a}
T9	10.55^{a}	7.72^{a}	5.86^{a}	2.29^{a}

* The average number followed by superscript of the same letter in each column is not significantly different based on *Duncan's Multiple Range Test* (α = 0.05); DHG (dry harvested grain), DMG (dry milled grain).

The weight of DHG was significantly higher compared to plants cultivated with different growing media compositions with an average DHG < 20 g per plant. The percentage of grain weight loss from DHG to DMG for T2 was an average of 17.95%, lower than an average of 22.78% for the overall treatments. The lowest number of panicles (9 panicles per plant), the weight of DHG (5.86 g), the weight of DMG (4.53 g) were obtained when the plants were cultivated with a growing medium consisting of soil, biochar, and nano-silica (T3) that also produced the lowest number of tillers during the growth period. Such low values of tillers and panicles because the plants were not provided with synthetic fertilizer and urea as sources of nutrients during the growth period.

The weight of 100 grains for all treatments showed insignificant results, indicating that the different growing media compositions did not affect the overall grain size. The size of rice grains represented by the weight of 100 grains was more influenced by the genetic characteristics of the plant compared to the growing media composition used in this study. It has been reported that the variety of Inpago 7 should be able to produce ± 2.45 g per 100 grains (www.litbang.pertanian.go.id, 2002). The results obtained in this study were slightly lower because the plants were harvested after 100 days, 11 days sooner than the standard cultivation time for *O. sativa* var. Inpago 7 and consequently, the formation of the grains was not optimized.

Growing media that contain enough nutrients shows a better effect on the growth and productivity of *O. sativa* var. Inpago 7 in comparison to the plants that were cultivated with growing media that had not sufficient nitrogen, phosphorus, and potassium elements. In addition, the application of sprayed nano-silica also promotes better plant growth and increases biomass productivity. This is in line with the previous study by Marxen that the weight of rice grains for plants provided with 17.3 milligrams of silica per hectare increased by 35% compared to the plants that were not provided with silica (Marxen & Klotzbucher, 2016). The plants could absorb 37% of the provided silica (0.4 mg Si ha^{-1}) through their straws, positively affecting DHG and DMG. Increasing of biomass and yield on growing media with added biochar in line with the previous study by Jeffery et al. that addition biochar in soil or growing media can increased crop growth, thus significantly enhancing crop production in terms of either yield or biomass (Jeffery et al., 2011), and according to research conducted by Chen et al., who found that biochar increased grain per panicle through promoting rice grain (Chen et al., 2013). The potential improvement in crop yield from the addition of biochar has been explained by several mechanism, such as improved soil properties, favourable surroundings of root growth and modified soil nutrient status (Si et al., 2018).

According to Menna et al. Si fertilizer are applied in several crops for increased productivity and sustainable production. Addition of silica have suggested growth effect which increased biomass, yield, pollination, and yield parameters. It boosted up crop growth and accumulation of more photo-assimilates from source to sink and consequently, it led to higher grain yield (Meena et al., 2014). Ahmed et al. found that the increase in Si leads to increase in leaf area index, specific leaf weight, chlorophyl content, leaf dry weight, root dry weight, total dry weight and remarkable decrease in leaf water potential and shoot to root ratio (Ahmed et al., 2011). Due to a synergistic effect, applied Si has the potential to raise the optimum rate of N, thus helping to enhance yields. Si plays an important role in hull formation in rice and grain quality. Si deficiency always reduces the number of panicles per square meter and percentages of filled grains. It has significant effect on the percentage of filled spikelet and the number of spikelet per panicle, most carbon in the rice grain comes from photoassimilate produced in leaves (especially the flag leaf) during the grain-filling period (Detmann et al., 2012). Barley grains that were harvested from a silicon-fertilized plot had better germination than grains form no silicon fertilizer applied plots. Application of Si fertilizer accelerated citrus growth by 30–80%, speeded up fruit maturation by 2–4 weeks, and increased quantity. Sorghum also accumulates silica in the phytoliths. It enhances the crop quality, yield, growth and protects the plant from various biotic and abiotic hurdles (Meena et al., 2014).

CONCLUSIONS

In brief, growing media composition influenced the growth and productivity of *O. sativa* var. Inpago 7. The highest number of panicles, the weight of dry harvested grain, and dry milled grain were obtained when the plants were cultivated with a growing medium containing soil, biochar, synthetic fertilizer, urea, and nano-silica that also produced the highest number of leaves and tillers during the growth period (15 days, 30 days, and 45 days). The results showed that the highest number of panicles (24 panicles per plant), the weight of dry harvested grain (21.74 g per plant), and weight of dry milled grain (17.83 g per plant) were obtained when cultivated with a growing medium containing soil, biochar, synthetic fertilizer, urea and sprayed with nano-silica. Nevertheless, the weight of 100 grains was not influenced by the growing media composition, which highlights that the overall grain size was more influenced by the genetic characteristics of the plant compared to the growing media composition used in this study. An appropriate combination of soil, biochar, synthetic fertilizer, urea, and sprayed with nano-silica is recommended as a growing media for cultivating *O. sativa* L. var. Inpago 7.

ACKNOWLEDGEMENTS. This work was financially supported by a research grant from Institut Teknologi Bandung.

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