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The combination of plant growth regulators (GA3 and *Gracilaria* sp. extract) and several fertilisers in Salak Pondoh fruit production

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Abstract: Plant growth regulators (PGRs) and proper fertilisers are used to increase quality of the Salak Pondoh, such as in the plant production, fruit number and size. This study aims to determine the type and dosage of PGRs and the best type of fertiliser to increase the production bunch and fruit of Salak Pondoh. The method used was a Factorial Completely Randomised Design (FCRD) with 36 treatments (excluding the control) and 3 replications. Three treatments were conducted: first, as a control, no PGR treatment + fertilisation (no fertilisation, manure, and NPK). Second, a 3 × 3 factorial scheme. Treatment of PGR GA3 (50, 100, 150 ppm) + fertilisation (no fertilisation, manure, and NPK). Third, a 3 × 3 × 3 factorial scheme was used. Treatment of PGR *Gracilaria* sp. extract (50, 100, 150 ppm) with different solvents (*n*-Hexane, methylene-chloride, ethanol) + fertilisation (no fertilisation, manure, and NPK). The parameters observed were the number length, area of the bunch, length and area of the fruit. The results showed the highest number of bunches was found in PGR GA3 50 ppm. While, the highest bunch area was found in PGR *Gracilaria* sp. ethanol 150 ppm. The PGRs only increased the formation of the bunches and did not increase the length and width of the bunches and the fruit size. Fertilisation affected the Salak production in the form of the number, length and width of the bunches, and the fruit size. In addition, the fertiliser increased the number of the bunches, bunch area, and length and area of the fruit. The interaction of the PGR and fertilisation had no significant effect on increasing the Salak Pondoh production. The best result in increasing the Salak Pondoh production was PGR *Gracilaria* sp. ethanol 100 ppm with manure fertilisation.

Keywords: bunch; ethanol; manure; *Salacca edulis*

Salak is a member of the Araceae plants, spread throughout tropical areas such as Indonesia, especially on Sumatra and Java (Supapvanich et al. 2011; Saleh et al. 2018). Salak is also known as snake fruit because it has a layer of skin in the form of red-brown scales (Aralas et al. 2009). Salak Pondoh is one of the Salak varieties from Yogyakarta, which has a super quality compared to other varieties (Lestari et al. 2013) (Figure 1). Fresh Salak from Indonesia has been exported to several countries as Singapore, Malaysia, Hong Kong, and China (Lestari et al. 2011; Setiawan 2019). One of the efforts to increase fruit formation was improving the plant quality and internal physiology by providing organic chemical compounds or plant growth regulators (PGRs) (Bons, Kaur 2020).

Gibberellin (GA3) is used as a plant growth regulators (PGR) to control the process of fruit formation (Kaur 2017). GA3 controls the fruit formation in various ways as well as the different fruit formation processes, such as pre-pollination, pollination, fertilisation, flowering, after flowering, fruit dehydration, and ageing (Suman et al. 2017). The weakness of using GA3 as a PGR is that the price is too high, and excessive doses can lost of yield (Susilawati et al. 2014).

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Figure 1. Salak Pondoh fruit set

A seaweed extract application (*Kappaphycus* sp. and *Gracilaria* sp.) improved the crop quality and nutrient uptake (N, P, and K) (Pramanick et al. 2014). Seaweed (*Gracilaria* sp.) is a genus of red algae that is spread throughout Asia (Zhang et al. 2019). The *Gracilaria* sp. extract contains PGRs in the form of auxin (191 ppm), GA3 (509.5 ppm), cytokinin-kinetin (244.5 ppm), and cytokinin-zeatin (70.5 ppm) (Basmal et al. 2020). A seaweed extract can increase the plant growth in the form of the roots, shoots, chlorophyll content, increased nutrient uptake, flowering, and fruit which also increase the amount of production, delay the senescence process, and increase the fruit shelf life (Satish et al. 2015). On the other hand, algae extracts have the advantage of being harmless, non-toxic, and non-polluting (Rathore et al. 2009; Lodhi, Diwan 2018).

Distinctive methods ensure the maximisation of the content in *Gracilaria* sp. to produce high yields. Various solvents can expand during the maceration process (Kurniawati et al. 2016). The type of solvent used in the extraction process can affect the acquisition of the content of the plant's active substance. Therefore, using the best solvent will increase the optimisation of the sample extraction (Zulharmita et al. 2010).

On the other hand, manure is also often used as an additional fertiliser. Manure significantly affects the soil-plant N dynamics and soil productivity when continuously used (Leite, Madari 2011; Singh et al. 2014). Cow manure can improve the soil properties through the availability of nutrients. Mustikawati et al. (2019) reported that the treatment of cow manure independently affected the growth of patchouli within 22 weeks after planting. In addition, nitrogen, phosphorus, and potassium (NPK) are the main soil nutrients needed for the complete plant growth (Sahoo et al. 2015). Rivai et al. (2017) stated that an NPK fertiliser can increase the growth of *Anchomanes difformis* plants with an optimum dose of 100kg/ha.

Several studies on the combination of PGRs and fertilisers for plants gave positive results, such as the application of NPK and GA3 fertilisers to flax plants (Ullah et al. 2017), phosphate fertilisers and PGRs (Cytokinins, Gibberellins) on the growth of Oryza sativa (Fitri et al. 2018), and the application of PGRs (auxins, cytokinins, gibberellins) and nitrogen fertilisation on the production of *Brachiaria decumbens* (Rocha et al. 2019). However, research on the combination of PGR (*Gracilaria* sp. & GA3) and a fertiliser (manure & NPK fertiliser), especially on Salak Pondoh has never been performed. Therefore, the purpose of this study was to determine the type and dose of ZPT and the suitable type of fertiliser to increase the production of bunches and fruits of Salak Pondoh.

MATERIAL AND METHODS

Time and place. The research was conducted in Pucang Anom Village, Slumbung District, Muntilan Regency, Central Java Province in January–December 2020. The PGR was undertaken in the Faculty of Science and Mathematics Chemistry Laboratory, Diponegoro University, Semarang.

Materials. The main ingredient of this research was the Salak Pondoh (*Salacca edulis* Reinw.) cultivar from farmers in Muntilan. The materials used were PGR GA3, *Gracilaria* sp., an *n*-Hexane solvent, methylene-chloride, and ethanol for the extraction of *Gracilaria* sp. manure from cow dung and an NPK fertiliser which can be commercially obtained.

Research design. The plants in the Salak Pondoh plot were four years old. This study used a Completely Randomised Factorial Design (CRFD). The treatments were divided into three treatments:

First, as a control, no PGR treatment + fertilisation (no fertilisation, manure, and NPK)

Second, a 3 × 3 factorial scheme. A PGR GA3 treatment (50, 100, 150 ppm) + fertilisation (no fertilisation, manure, and NPK).

Third, a 3 × 3 × 3 factorial scheme was used. A PGR *Gracilaria* sp. extract treatment (50, 100, 150 ppm) with different solvents (*n*-Hexane, meth-

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ylene-chloride, ethanol) + fertilisation (no fertilisation, manure, and NPK)

There were 36 treatments (excluding the control treatment) with three replications.

***Gracilaria* sp. extraction for PGR.** The *Gracilaria* sp. seaweed was prepared and cleaned in advance. The *Gracilaria* sp. seaweed was handpicked from Teluk Awur, Jepara, Central Java. The PGR from *Gracilaria* sp. was made with different solvents, namely *n*-Hexane, methanol, and ethanol. Soaking was performed three times within 72 hours. The extract solution of *Gracilaria* sp. was ready to use with a spray application on the female Salak Pondoh flowers.

Application of plant growth regulator and fertiliser. Pollination was undertaken by mating female plants with male plants using human assistance. Female Salak plants that were mated were left for one week. After the successful pollination, the female plants were sprayed with the PGR treatment. The PGR treatments were applied four times once every two weeks. The PGR concentrations used were 50 ppm, 100 ppm, and 150 ppm. The type of fertiliser used was a manure and an NPK fertiliser. Manure was added at a dose of 5 kg per plant and the NPK fertiliser was added 100 g per plant. Fertilisation was undertaken once at the beginning of the rainy season.

Observation. The female Salak plants were observed for three months. Routine observations were carried out every week in each garden to see the development of the Salak Pondoh flowers. The observed parameters consist of the Salak Pondoh bunches and fruit. The bunch parameters were the number of bunches, the bunch length, and the bunch area, while the fruit parameters were the length and width of the fruit. They were observed every month.

Statistical analysis. The data obtained were tested using an analysis of variance (ANOVA) test method at a 95% significance level and a further test was carried out with Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Salak bunch. The highest number of Salak Pondoh bunches was found with the PGR GA3 50 ppm treatment without fertilisation at 2.78 ± 0.51 bunches, followed by the PGR *Gracilaria* sp. ethanol 100 ppm treatment without fertilisation at 2.56 ± 0.19 bunches (Table 1). Gibberellin (GA3) is one of the necessary hormone in plant development process and in initiation of fruit bunches (Chai et al. 2018). GA3 was applied when the flowering phase of the plant showed an increase in the bunch formation (Popenoe, Campbell 2018). Salak Pondoh plantations that are not fertilised will be more susceptible to biotic and abiotic stresses. It also affects the plant survival because the fertiliser can fulfil the nutrient needs in the soil

Table 1. The number of Salak bunches with the different PGR and fertilisation applications

Parameters	Concentration (ppm)	Fertilizer*			Average
		without fertiliser	manure	NPK	
Control	–	0.67 ± 0.58	1.67 ± 0.00	1.78 ± 0.38	1.37^{cd}
	50	2.78 ± 0.51	1.56 ± 0.19	1.33 ± 0.58	1.89^{b}
GA3	100	1.89 ± 0.76	1.56 ± 0.19	1.67 ± 0.00	1.70^{bc}
	150	1.11 ± 0.38	2.00 ± 0.00	2.11 ± 0.19	1.74^{bc}
Solvent *Gracillaria sp.*					
	50	1.67 ± 0.00	1.67 ± 0.00	1.33 ± 0.57	1.56^{bcd}
n-Hexane	100	1.22 ± 0.77	2.00 ± 0.00	1.33 ± 0.57	1.51^{bcd}
	150	0.89 ± 0.76	1.44 ± 0.38	1.56 ± 0.19	1.29^{d}
	50	0.89 ± 0.76	2.00 ± 0.00	2.11 ± 0.19	1.67^{bcd}
Methylene-chloride	100	1.11 ± 0.38	1.56 ± 0.19	2.00 ± 0.00	1.56^{bcd}
	150	1.44 ± 0.38	2.00 ± 0.00	1.22 ± 0.19	1.56^{bcd}
	50	1.56 ± 0.19	2.00 ± 0.00	1.67 ± 0.33	1.74^{bc}
Ethanol	100	2.56 ± 0.19	1.89 ± 0.19	2.33 ± 0.33	1.26^{a}
	150	1.11 ± 0.38	1.67 ± 0.00	2.00 ± 0.00	1.59^{bcd}
Average		1.45^{b}	1.72^{a}	1.73^{a}	(–)

Numbers in rows and columns followed by the same letters show no difference at a 95% confidence level according to Duncan's Multiple Range Test (DMRT)

(–) – There is no interaction between the factors; *value ± standard deviation

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and replace the nutrient losses, hence it will increase the plant production. However, according to Shinozaki et al. (2015), the performance of GA3 will decrease if there is biotic or abiotic stress.

The width and length of the Salak Pondoh bunches show that there was no effect on the interaction between the PGR and fertilisation addition (Tables 2 and 3). However, a single factor like the form of the PGR application had a significant effect on the number of bunches and bunch area. The PGR *Gracilaria* sp. ethanol treatment produced the highest bunch total (dose of 100 ppm) and the maximum value of the bunch width and length was obtained with a dose of 150 ppm. Algae are a source of PGR containing 1-naphthaleneacetic acid (NAA), kinetin, zeatin, gibberellin, auxins, and cytokinins (Lodhi, Diwan 2018). The type of auxin that has a function to control the fruit formation is indole-3-acetic acid (IAA) (Pomares-Viciana et al. 2018). GA interacts with IAA in the cell division and elongation process during the fruit bunch formation (An et al. 2020). Observations indicate that IAA and GA have a similar role in increasing the number of bunches (Sarkar et al. 2002). In general, the addition of PGR containing IAA functions as to increase the cell division, and the GA function deals with the cell enlargement at the next level (Hu et al. 2018). The complete PGR components in *Gracilaria* sp. can improve the plant growth and development. The addition of hormones, such as IAA, Zeatin, and GA, after pollination inhibits the shedding of fruit candidate flowers, thereby increasing the fruit formation (Boonkorkaew et al. 2008).

The single factor in the fertiliser application provided significant differences in the number and area of Salak bunches. The highest number and area of the bunches were found in the fertilisation that used manure. The function of the organic fertiliser application preserved the mineral content in the leaves during the growth process, increasing the bunch formation percentage, and reducing the fruit drop (Hegazi et al. 2007). According to Al-Kahtani et al. (2012), the removal of the nutrients through manure takes a long time, thereby increasing the ability of soil microorganisms to produce PGRs such as auxins, gibberellins, and cytokines that function in the flowering process.

Fruit set. The results show no interaction between the PGRs with the different fertilisers on the length and width of the Salak Pondoh fruit (Table 4). The highest fruit length and width was found in the PGR *Gracilaria* sp. methylene-chloride 150 ppm treatment, while the lowest was found in the control treatment. Methyl chloride is an appropriate solvent for the production of PGR from *Gracilaria* sp. Consequently, the content of plant extracts is optimal in stimulating the formation and development of the fruit. This was reinforced by the results of the plants that did not receive

Table 2. Results of the measurement analysis of the Salak Pondoh bunch width based on the PGR and different fertilisation applications (in cm)

Parameters	Concentration (ppm)	Fertilizer*			Average
		without fertiliser	manure	NPK	
Control	–	31.26 ± 14.73	56.25 ± 19.66	38.33 ± 12.94	36.93^{ab}
	50	40.48 ± 14.67	56.02 ± 27.13	30.6 ± 16.99	42.19^{ab}
GA3	100	33.01 ± 3.96	59.83 ± 21.41	38.38 ± 7.72	43.74^{ab}
	150	28.99 ± 0.38	53.65 ± 8.11	33.32 ± 4.78	38.65^{ab}
Solvent*Gracillaria* sp.					
	50	44.10 ± 18.38	54.67 ± 20.55	30.37 ± 2.91	43.04^{ab}
n-Hexane	100	26.55 ± 8.78	44.41 ± 22.72	28.31 ± 3.05	33.09^{b}
	150	25.14 ± 21.77	50.24 ± 21.10	30.27 ± 3.33	35.22^{b}
	50	16.94 ± 14.67	52.07 ± 22.39	44.15 ± 12.97	37.72^{ab}
Methylene-chloride	100	27.32 ± 5.01	53.42 ± 25.34	49.24 ± 11.77	43.33^{ab}
	150	27.11 ± 8.04	63.75 ± 14.42	35.08 ± 5.86	41.98^{ab}
	50	36.17 ± 5.37	63.43 ± 31.80	42.11 ± 15.15	47.23^{ab}
Ethanol	100	55.38 ± 18.70	58.02 ± 19.62	9.24 ± 21.65	40.88^{ab}
	150	26.06 ± 3.67	65.46 ± 28.70	52.51 ± 21.83	48.01^{a}
Average		31.26^{b}	56.25^{a}	38.33^{b}	(–)

Numbers in rows and columns followed by the same letters show no difference at a 95% confidence level according to DMRT (–) – There is no interaction between the factors; *value ± standard deviation

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Table 3. Results of the measurement analysis of the Salak Pondoh bunch length based on the PGR and different fertilisation applications (in cm)

Parameters	Concentration (ppm)	Fertilizer*			Average
		without fertiliser	manure	NPK	
Control	–	31.26 ± 14.73	56.25 ± 19.66	38.33 ± 12.94	36.93^{ab}
	50	40.48 ± 14.67	56.02 ± 27.13	30.6 ± 16.99	42.19^{ab}
GA3	100	33.01 ± 3.96	59.83 ± 1.41	38.38 ± 7.72	43.74^{ab}
	150	28.99 ± 0.38	53.65 ± 8.110	33.32 ± 4.78	38.65^{ab}
Solvent *Gracillaria* sp.					
	50	44.10 ± 18.38	54.67 ± 20.55	30.37 ± 2.91	43.04^{ab}
n-Hexane	100	26.55 ± 8.78	44.41 ± 22.72	28.31 ± 3.05	33.09^{b}
	150	25.14 ± 21.77	50.24 ± 21.10	30.27 ± 3.33	35.22^{b}
	50	16.94 ± 14.67	52.07 ± 22.39	44.15 ± 12.97	37.72^{ab}
Methylene-chloride	100	27.32 ± 5.01	53.42 ± 25.34	49.24 ± 11.77	43.33^{ab}
	150	27.11 ± 8.04	63.75 ± 14.42	35.08 ± 5.86	41.98^{ab}
	50	36.17 ± 5.37	63.43 ± 31.80	42.11 ± 15.15	47.23^{ab}
Ethanol	100	55.38 ± 18.70	58.02 ± 19.62	9.24 ± 21.65	48.01^{ab}
	150	26.06 ± 3.67	65.46 ± 28.70	52.51 ± 21.83	54.21^{a}
Average		59.01^{ab}	54.52^{b}	68.07^{a}	(–)

Numbers in rows and columns followed by the same letters show no difference at a 95% confidence level according to DMRT (–) – There is no interaction between the factors; *value ± standard deviation

the GA3 treatment or PGR *Gracilaria* sp., which had the lowest fruit sets.

The other results of this study were related to the PGR dosing. The PGR *Gracilaria* sp. *n*-Hexane 150 ppm and PGR *Gracilaria* sp. methyl chloride 50 ppm treatments grown in the garden without fertilisation did not produce any fruit. An inappropriate content or the administration of PGR can result in a decrease in the fruit production. Small concentrations of IAA can decrease the fruit size, chlorophyll content, and fruit weight (Khandaker et al. 2018), even though auxin played a role in the cell division, elongation, and differentiation processes which affected the shape of the fruit (Liu et al. 2020).

The single factor in the PGR application did not affect the length and width of the Salak Pondoh fruit. The PGR *Gracilaria* sp. ethanol 100 ppm treatment produced the highest fruit width at 17.66 cm (Table 5). The lowest fruit length was found in the PGR *Gracilaria* sp. *n*-Hexane 150 ppm treatment, which was 9.52 cm. Ethanol and methyl chloride are polar compounds, while *n*-Hexane is non-polar. In several studies, ethanol was used as a solvent in the extraction process.

Several active substances are slightly soluble in water or unstable, therefore a suitable concentrated solution is needed to dissolve the active substance, where the solvent is miscible with water, such as ethanol (Wikeley et al. 2020). The polarity of the solvent is an important indicator in the extraction (Nawaz et al. 2020), so that, in this study, the extraction of *Gracilaria* sp. did not obtain optimal results with *n*-Hexane as the solvent. This affects the PGR applied to the Salak Pondoh plant. Research by Lordan (et al. 2019) stated that the administration of GA3 on day seven after pollination did not increase the fruit size, but only increased the fruit formation. This is possibly what causes the PGR to not increase the size of the Salak Pondoh fruit.

The single factor in the form of the different fertilisation treatments provided a significant difference in the fruit size, especially the length and width of the fruit. The highest fruit width was found in the fertilisation treatment using manure at 25.10 cm followed by the fertilisation treatment using NPK and without the fertilisation at 10.93 cm and 5.83 cm, respectively. Fertilisation using manure produces fruit sizes larger than the NPK fertilisation. The nitrogen in the manure can increase the N content in the soil during the plant's growth (Duan et al. 2016). Nitrogen also increases the size of chillies (Khandaker et al. 2017).

Manure has a higher water content, at about 85%, which will affect the decomposition process and availability of nutrients more quickly, this can acceler-

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Table 4. Results of the analysis of the width of the Salak Pondoh fruit with the different PGR and fertilization treatments (in cm)

Parameters	Concentration (ppm)	Fertilizer*			Average
		without fertiliser	manure	NPK	
Control	–	0.00 ± 0.00	22.17 ± 8.40	7.45 ± 8.79	9.87[a]
	50	11.35 ± 13.75	21.56 ± 14.90	11.46 ± 13.23	14.79[a]
GA3	100	8.64 ± 4.20	27.24 ± 8.81	14.07 ± 4.48	16.65[a]
	150	5.63 ± 2.66	30.75 ± 6.91	13.38 ± 12.97	16.58[a]
Solvent *Gracillaria* sp.					
	50	10.01 ± 12.65	25.03 ± 7.57	6.84 ± 3.51	13.96[a]
n-Hexane	100	2.89 ± 4.04	21.88 ± 10.49	4.58 ± 4.23	9.78[a]
	150	0.00 ± 0.00	23.69 ± 4.42	4.88 ± 5.79	9.52[a]
	50	0.00 ± 0.00	23.17 ± 8.16	10.68 ± 12.05	11.28[a]
Methylene-chloride	100	11.84 ± 19.20	23.71 ± 9.32	9.80 ± 10.14	15.12[a]
	150	6.37 ± 2.91	30.38 ± 7.75	9.34 ± 8.20	15.36[a]
	50	6.89 ± 9.39	25.16 ± 12.20	10.89 ± 13.65	14.31[a]
Ethanol	100	9.74 ± 13.26	25.50 ± 7.53	17.74 ± 11.41	17.66[a]
	150	2.46 ± 4.26	26.08 ± 8.68	20.96 ± 10.09	16.50[a]
Average		5.83[c]	25.10[a]	10.93[b]	(–)

Numbers in rows and columns followed by the same letters show no difference at a 95% confidence level according to DMRT (–) – There is no interaction between the factors; *value ± standard deviation

ate the absorption and plant growth (Prasetya 2014). Sarno (2009) reported that applying manure at a dose of less than 5 mg/ha combined with an NPK fertiliser is not effective in affecting the soil properties, growth, and yield of caisim production. In contrast, manure with a dose greater than 5 Mg/ha had a significant effect on increasing the C-total, N-total, available P and K, growth, and yield of caisim.

Table 5. Results of the fruit length analysis of the Salak Pondoh plants on the PGR and different fertilisation treatments (in cm)

Parameters	Concentration (ppm)	Fertilizer*			Average
		without fertiliser	manure	NPK	
Control	–	0.00 ± 0.00	19.90 ± 8.18	6.79 ± 7.89	8.89[a]
	50	11.10 ± 13.21	19.47 ± 15.16	9.96 ± 10.80	13.51[a]
GA3	100	7.72 ± 4.41	25.32 ± 8.72	8.69 ± 7.18	13.91[a]
	150	3.62 ± 1.68	28.49 ± 8.02	10.65 ± 13.05	14.25[a]
Solvent *Gracillaria* sp.					
	50	8.79 ± 11.93	23.09 ± 8.52	5.78 ± 3.74	12.55[a]
n-Hexane	100	2.73 ± 4.020	20.09 ± 8.52	5.78 ± 3.74	9.05[a]
	150	0.00 ± 0.000	22.29 ± 6.16	4.51 ± 5.33	8.93[a]
	50	0.00 ± 0.000	19.69 ± 9.19	9.87 ± 11.06	9.85[a]
Methylene-chloride	100	2.94 ± 4.190	20.63 ± 9.73	8.69 ± 9.04	10.75[a]
	150	5.72 ± 2.590	29.63 ± 8.19	8.42 ± 7.76	14.59[a]
	50	6.76 ± 9.220	23.46 ± 10.96	9.66 ± 12.07	13.29[a]
Ethanol	100	9.09 ± 13.02	24.09 ± 9.07	15.25 ± 11.28	16.14[a]
	150	2.13 ± 3.680	22.63 ± 9.50	18.92 ± 10.24	14.56[a]
Average		4.66[c]	23.00[a]	9.33[b]	(–)

Numbers in rows and columns followed by the same letters show no difference at a 95% confidence level according to DMRT (–) – There is no interaction between the factors; *value ± standard deviation

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CONCLUSIONS

This research shows that the highest number of bunches was found in the PGR GA3 of 50 ppm treatment, while the highest bunch area was found in the PGR *Gracilaria* sp. ethanol of 150 ppm treatment. The PGRs only increased the formation of bunches and did not affect any increase in the length and width of the bunches or fruit size. Fertilisation will affect the Salak production in the form of the number, length and width of the bunches, and the fruit size. In addition, the fertiliser can increase the number of bunches, the bunch area, and the length and area of the fruit. The interaction of the PGR and the fertilisation had no significant effect on increasing the production of the Salak Pondoh. The best fertilisation treatment to increase the Salak Pondoh production was fertilising using 5 kg/plant of manure. Further studies are needed to be optimised related to the PGR (GA3 and *Gracilaria* sp. extract) and fertilisation (manure and NPK) treatments to increase the Salak Pondoh productivity.

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