Ilmu Pertanian (Agricultural Science)
Vol. 2 No. 3 December, 2017 : 100–105
Available online at http://journal.ugm.ac.id/jip
DOI: doi.org/10.22146/ipas.28293

The Effect of Plant Growth Regulator on Duku (*Lansium domesticum* Corr.) Flower for Fruit Formation

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Received: 14th September 2017 ; Revised: 21st December 2017 ; Accepted: 21December 2017

ABSTRACT

Plant growth regulators have a significant impact on increasing both quality and quantity of plant yield for either mixed or separated application. The research was aimed to identify the effect of spraying plant growth regulators on duku flowers for fruit formation. The research was conducted from December 2014 to May 2015 in Sijacarana Local Technical Implementation Unit (UPTD) of Propagation, South Sumatra Province in Ogan Komering Ulu (OKU) Timur Regency. Duku tree used was 15 years old with the height around 10 meter. Complete Randomized Design was used with 3 replications where duku trees as the replicates. The spraying consisted of 3 single plant growth regulator treatments and 6 mixed treatments which were P_1 (BAP 300 mg.L^{-1}), P_2 (NAA 300 mg.L^{-1}), P_3 (GA_3 300 mg.L^{-1}), P_4 (BAP 100 mg. L^{-1} + GA_3 200 mg.L^{-1}), P_5 (BAP 200 mg.L^{-1} + GA_3 100 mg.L^{-1}), P_6 (BAP 150 mg.L^{-1} + GA_3 150 mg.L^{-1}), P_7 (NAA 100 mg.L^{-1} + GA_3 200 mg.L^{-1}), P_8 (NAA 200 mg.L^{-1} + GA_3 100 mg.L^{-1}), P_9 (NAA 150 mg.L^{-1} + GA_3 150 mg.L^{-1}). Spraying was applied twice with a half dosage for each application. First application was performed about one month after flowering, and the second was one and a half month after flowering. Data were analyzed using analysis of variance and least significance difference at α 5%. The measurement of parameters were carried after harvest or 3 months after treatment. Results showed that plant growth regulator positively affected duku fruit formation. GA_3 treatment then was considered as the best treatment as it had a unison in fruit maturity, the highest number of fruit per bunch, weight per fruit and total fruit weight per bunch, and had the lowest number of green fruit and seed per fruit.

Keywords: Auxin, Cytokinin, Duku, Gibberellin

INTRODUCTION

Fruit crops are one of important horticulture commodities needed to be developed. Indonesian fruit consumption rate in 2006 was 23.46 kilograms per capita per year, increasing to 32.59 kilograms in 2010 (Directorate General of Horticulture, 2012). However, it is much less than 65 kilograms per capita per year as the recommended standard of Food Agricultural Organization (FAO) even though there is enormous potency for the development of domestic fruits to fulfill fruit consumption.

Duku (*Lansium domesticum* Corr.) is a tropical seasonal fruit distributed limitedly in Southeast Asia, including Indonesia, Malaysia and China (Lizawati *et al*., 2013). According to Central Bureau of Statistics (2015), duku production in Indonesia for three years from 2012-2014 were 258.453; 233.118; 208.424 tons per hectare per year, respectively. Thus, the effort for increasing national duku production through the improvement of cultivation techniques is beneficial to minimize the decreasing trends as aforementioned. One of the famous duku cultivars in Indonesia is Duku Palembang with sweet taste and thin fruit skin. Duku Palembang cv. is distributed in almost all regencies in South Sumatra, including in Musi Banyuasin, Banyuasin, Ogan Komering Ilir, Ogan Komering Ulu, Lahat, Musi Rawas and Muara Enim (Uji, 2007; Deroes and Wijaya, 2010). The problem is in each fruit usually containing one-two seed that cause inconvenient for consuming it. The effort to increase duku quality to maintain the sweet taste and thin fruit skin beside to produce seedless fruit is required.

The application of plant regulator growth in low dosage could trigger either biochemical, physiological or morphological reaction such as stimulating, inhibiting, or transforming.the application of 300 mg.L^{-1} GA_3

could decrease the average of seed number from 31.08 to 13.67 in watermelon (Wijayanto *et al*., 2012). According to Murni *et al*. (2008), GA_3 concentration of 100 to 150 ppm was the optimum range for the germination and vegetative growth of duku. Research by Karjadi and Buchrory (2007) found out the optimal dosage of 2.5 – 7.5 $mg.L^{-1}$ BAP and 0 $mg.L^{-1}$ NAA for leaf number growth and plant height in garlic tissue culture. While for root development was obtained in the range of 2.5 $mg.L^{-1}$ NAA and 2.5 $mg.L^{-1}$ BAP.

Thus, this research was conducted to evaluate the effect of several plant growth regulators spraying on harvest time effect to the quality of duku fruit.

MATERIALS AND METHODS

This research was conducted in Sijacarana Local Technical Implementati on Unit (UPTD) of Propagation, South Sumatra Province in Ogan Komering Ulu (OKU) Timur Regency. The research was carried out from December 2014 to May 2015. Fifteen years old duku trees with the height of approximately 10 meters were used in the research. Other materials used were Benzyl Amino Purin (BAP), Naphtalene Acetic Acid (NAA), Gibberelic Acetic Acid (GA_3), alcohol, transparent plastic, and aquadest. The tools used were handsprayer, digital scale, and camera.

Complete randomized design with three replicates was used while the spraying treatments consisted of 3 single growth regulator treatments and 6 mixed treatments. The treatments included P_1 (BAP 300 mg $.L^{-1}$), P_2 (NAA 300 $mg.L^{-1}$), P_3 (GA_3 300 $mg.L^{-1}$), P_4 (BAP 100 $mg.L^{-1}$ + GA_3 200 $mg.L^{-1}$); P_5 (BAP 200 $mg.L^{-1}$ + GA_3 100 $mg.L^{-1}$); P_6 (BAP 150 $mg.L^{-1}$ + GA_3 150 $mg.L^{-1}$); P_7 (NAA 100 $mg.L^{-1}$ + GA_3 200 $mg.L^{-1}$); P_8 (NAA 200 $mg.L^{-1}$ + GA_3 100 $mg.L^{-1}$); P_9 (NAA 150 $mg.L^{-1}$ + GA_3 150 $mg.L^{-1}$).

Three duku trees served as the replicate. While the treatments were applied to nine flower bunches per tree (one treatment per each bunch), so that there were three replicates for each treatment resulted in total 27 experimental units. The spraying was applied twice; first at the period of 1 month and 1.5 months since flowering, each half dose of the treatment. The sprayed flowers were covered with clear plastic for one day to prevent the effects of rain. After one day the plastic lid was opened. Harvesting was carried out at the same time for all treatments based on the presence of bunch containing ripe fruits. All experimental units had to be harvested immediately at the same time when one fruit bunch had already ripe to anticipate the loss of the ripe fruit.

The data obtained were the number of fruit buds per bunch, number of fruit per bunch, number of green fruit per bunch, fruit diameter, fruit weight, number of seeds per fruit and total fruit weight per bunch. The resulted data then were analyzed by using anova (analysis of variance) and Least Significance Difference test at α = 1 %

The results showed that the highest number of fruit buds per bunch was of treatment P_5 (BAP 200 $mg.L^{-1}$ + GA_3 100 $mg.L^{-1}$) with 114 fruit buds, which was not significantly different from treatment P_1 (BAP 300 $mg.L^{-1}$) and P_9 (NAA 150 $mg.L^{-1}$ + GA_3 150 $mg.L^{-1}$) but significantly different from other treatments. The lowest number of fruit buds per bunch was treatment P_8 (NAA 200 $mg.L^{-1}$ + GA_3 100 $mg.L^{-1}$) with 75 fruit buds, which was significantly different from treatment P_1, P_5 and P_9 but was not significantly different from other treatments.

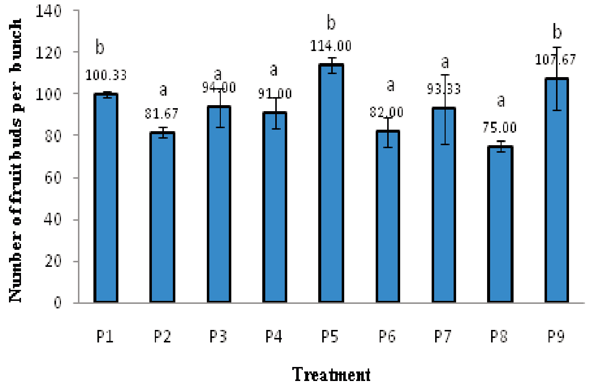
RESULT AND DISCUSSION

The results showed that the effect of spraying of plant growth regulator significantly aaffected all observed variables, i.e. number of fruit buds per bunch, number of fruit per bunch, number of green fruit per bunch, fruit diameter, fruit weight, number of seeds per fruit, total fruit weight per bunch. The variability coefficient of all parameters ranged from 9.60 to 21.29 % (Table 1).

Table 1. Analysis of variance of the observed variables

No.	Parameters	F stat.	CV (%)
1.	Number of fruit buds per bunch	195.14**	9.60
2.	Number of fruit per bunch	188.46**	11.07
3.	Number of green fruit per bunch	63.55**	21.29
4.	Fruit diameter (cm)	105.95**	9.68
5.	Fruit weight (g)	176.59**	9.86
6.	Number of seeds per fruit (seed)	51.91**	16.59
7.	Total fruit weight per bunch (g)	187.39**	11.57
	F (8,18; α = 0.01)	3.71	

Remarks: ** = very significant



Remarks: The bar show standard deviation; numbers followed by the same letters not significantly different based on LSD test at α = 5%.

Figure 1. The effect of plant growth regulator to the number of fruit buds per bunch.

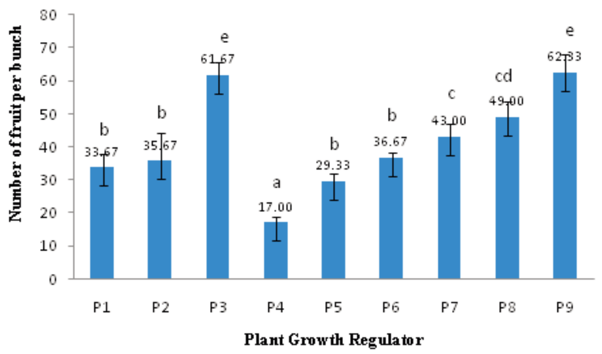


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Figure 2. The effect of Plant Growth Regulator on Number of fruit per bunch.

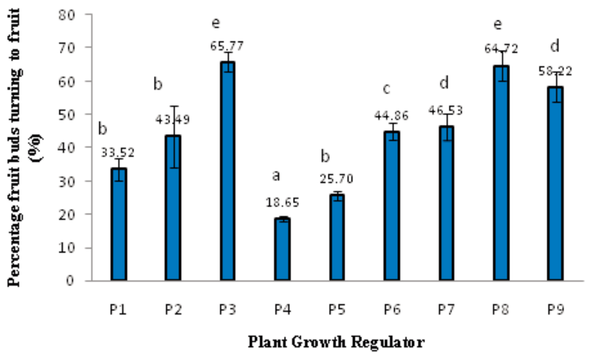

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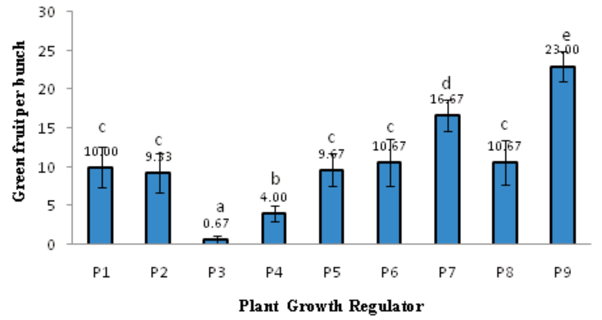
Figure 3. The effect of plant growth regulators on fruit buds turning to fruit (%).



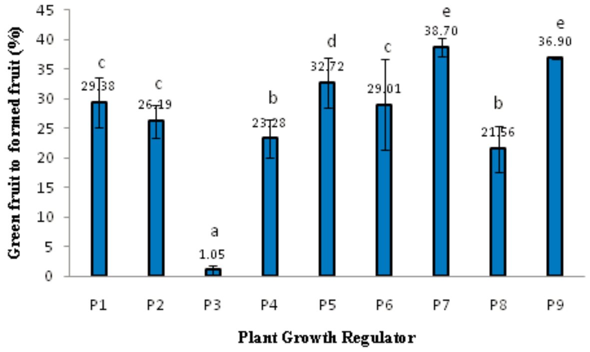
Remarks: The bar show standard deviation; numbers followed by the same letters not significantly different based on LSD test at α = 5%.

Figure 4. The effect of plant growth regulators on green fruit per bunch.

The results (Figure 1)showed that the highest number of fruit buds per bunch was of treatment P_5 (BAP 200 mg.L^{-1} + GA_3 100 mg.L^{-1}) with 114 fruit buds, which was not significantly different from treatment P_1 (BAP 300 mg.L^{-1}) and P_9 (NAA 150 mg.L^{-1} + GA_3 150 mg.L^{-1}) but significantly different from other treatments. The lowest number of fruit buds per bunch was treatment P_8 (NAA 200 mg.L^{-1} + GA_3 100 mg.L^{-1}) with 75 fruit buds, which was significantly different from treatment P_1, P_5 and P_9 but was not significantly different from other treatments.

Based on the result of the research (Figure 2), it is obtained the pattern of single plant growth regulator treatment (cytokinin, auxin and gibberellin) effect and mixed plant growth regulator (cytokinin + gibberellin and auxin + gibberellin) effect. Separately application of cytokinin, auxin and gibberellin produce the number of fruit were 33.67; 35.67 and 61.67 respectively. This result was in line with the result of the application of 40 ppm of GA_3 on tomato plants that produced highest number of fruit compared to other treatments (NAA 15 - 45 ppm and 2.4-D 5-15 ppm) (Verma *et al*., 2014). In the same pattern, for mixed treatment, the number of fruit formed in the mixture of cytokinin and gibberellin was relatively lower than that of auxin and gibberellin. Another research on two varieties of mango plants for two years by Nkansah *et al*. (2012) found that mango plants sprayed with 25 ppm GA_3 and 25 ppm NAA produced the highest number of fruit per plant compared to other treatments. However, both mixtures had the same pattern that the highest number of fruit was obtained in a balanced mixture of cytokines and gibberellin (P_6 = BAP 150 mg.L^{-1} + GA_3 150 mg.L^{-1}) or of auxin and gibberellin (P_9 = NAA 150 mg.L^{-1} + GA_3 150 mg.L^{-1}).

Based on Figure 2, the highest number of fruit in P_9 treatment (62.33 fruits) was not significantly different from P_3 (GA_3 300 mg.L^{-1}), treatment (61.67 fruits) and the lowest was in P_4 (BAP 100 mg.L^{-1} + GA_3 200



Remarks: The bar show standard deviation; numbers followed by the same letters not significantly different based on LSD test at α = 5%.

Figure 5. The effect of plant growth regulators on number of green fruit to formed fruit.

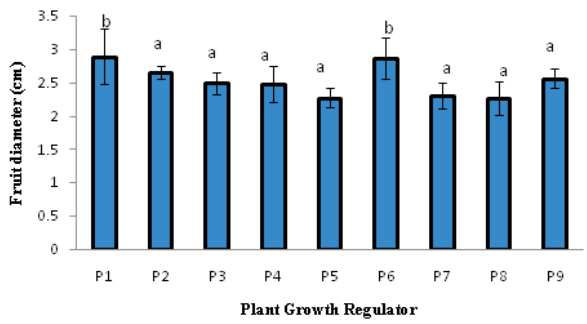


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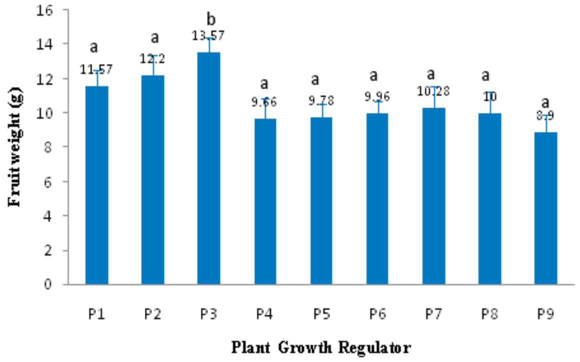
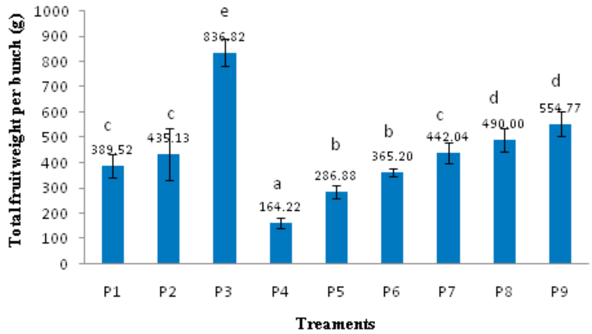
Figure 6. The effect of plant growth regulators on fruit diameter (cm).



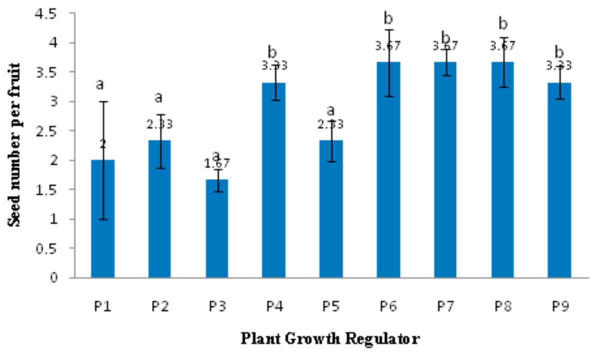
Remarks: The bar show standard deviation; numbers followed by the same letters not significantly different based on LSD test at α = 5%.

Figure 7. The effect of plant growth regulators on fruit weight.



Remarks: The bar show standard deviation; numbers followed by the same letters not significantly different based on LSD test at α = 5%.

Figure 8. The effect of plant growth regulators on total fruit weight per bunch.



Remarks: The bar show standard deviation; numbers followed by the same letters not significantly different based on LSD test at α = 5%.

Figure 9. The effect of plant growth regulators on number of seeds per fruit.

mg.L^{-1}) treatment (17 fruits) which was significantly different from other treatments.

Based on data of the number of fruit buds and the number of fruit per bunch, it was obtained the percentage of number of fruit formed from the fruit buds per bunch. The highest percentage of fruits formed was in treatment P_3 at 65.61 and the lowest was in treatment of P_4 (BAP 100 mg.L^{-1} + GA_3 200 mg.L^{-1}) at 18.68 (Figure 3). This result indicated the effect of gibberellin on the fruit formation process compared to other plant growth regulators either by its own or mixed. Masroor *et al*. (2006) stated that giving effective concentration would affect the number of fruit per plant and could increase the number of fruit set and prevent the loss of tomato fruit.

As the fruit developed differently, the result showed that the lowest number of green fruit per bunch (0.67) was in P_3 treatment, which was not significantly different from P_4, although it was 4.0 in P_4 treatment, and had significant difference from other treatments. The highest number of green fruit was in P_9 treatment at 23.0 (Figure 4). This condition showed the difference in fruit ripening due to some plant growth regulators spraying (Figure not shown). P_3 treatment generated the fastest fruit ripening that caused the lowest number of green fruit per bunch. It was assumed that gibberellins effect in fruit ripening process, so that flowers sprayed by gibberellin alone created earlier fruit ripening. An earlier research by Tiwari *et al*. (2012) stated that chili plants with GA_3 treatment ripened earlier those with auxin.

The lowest percentage of green fruit compared to formed fruit was obtained in treatment P_3 (gibberellin) and the highest was in P_7 treatment (NAA 100 mg. L^{-1} + GA_3 200 mg.L^{-1}) (Figure 5). The low percentage of green fruit compared to formed fruit showed that almost all fruit ripened faster in GA_3 treatment than in any other treatments. This is in line with the number of green fruit.

To understand the effect of plant growth regulators on fruit diameter, it was obtained that the highest fruit diameter was in P_1 treatment at 2.89 cm, which was insignificantly different from P_6 treatment at 2.86 cm, and significantly different from other treatments (Figure 6). There is no information about the effect of GA_3 on duku fruit. As on green fruit percentage, the fruit diameter was also affected by GA_3 that the formed fruit became smaller in chili plant. The smaller size was due to the lengthened fruit. Yasmin *et al*. (2014) showed the result of GA_3 usage in the early stage of fruit forming yielded in longer fruit compared to the application in blossoming stage.

The research result showed that the change of the duku flowers into the fruit was visually not noticeable by shape, but was indicated by the change of color from green to light yellow. The change occurred one week after the second spray for all treatments (Data not shown). It is assumed that at the blossoming stage fertilization started to begin and plant growth regulators spraying progressively triggered the fruit formation process.

The different effect of varied plant growth regulators on fruit development process showed that the data of number of green fruit was in accordance with fruit weight, number of seeds per fruit, and total weight of fruit per bunch. The highest fruit weight and total fruit weight per bunch was obtained by P_3 treatment, both variables are significantly different from other treatments. While the lowest fruit weight was obtained by P_9 treatment at 8.90 g which was insignificantly different from other treatments except from P_3 treatment. On the other hand, the lowest total fruit weight per bunch was obtained by P_4 treatment at 164.22 g which was significantly different from other treatments (Figure 7 and 8). Gelmesa *et al*.(2010) stated that the implementation of GA_3 concentration coud increase the fruit weight in average of 27 % compared to those without GA_3 treatment. There was a real difference between 40 ppm concentration and the control of total fruit harvest. The research from Permatasari *et al*. (2016) on tomato fruit pointed out that the higher gibberellin hormone concentration given the bigger fruit weight obtained. Applying gibberellin at 100 ppm concentration had a significant difference with the applications of 0 ppm, 60 ppm and 80 ppm concentration.

On the other hand, number of seeds per fruit variable was not in accordance with fruit weight and total fruit weight per bunch since the lowest data was found in P_3 treatment with 1.67 seeds, which insignificantly different from P_1, P_2 and P_5 treatments but significantly different from P_4, P_6, P_7, P_8 and P_9 treatments (Figure 9). The highest number of seeds was in P_6, P_7 and P_8 treatments with 3.67 seeds. A research on gibberellins effect on decreasing number of seeds had ever conducted by Wijayanto *et al*. (2012) on watermelon plant. The results showed that the implementation of GA_3 300 mg.L^{-1} reduced the average number of seeds from 31.08 to 13.67. Another research on tomato plant also showed the application of GA_3 with 40 ppm concentration could decrease 9.13% of seeds compared to the controlled groups (Rolistyo *et al*. 2014; Adnyesuari *et al*., 2015).

Generally, the data obtained qualitatively and quantitatively of this research from flower development to fruit harvest supported one another. Qualitatively, flowers got P_3 treatment (300 mg GA_3) produced relatively faster and equally ripening fruit compared to other treatments. Qualitatively, it was acquired that flowers with P_3 treatment (300 mg GA_3) produced relatively faster and equally ripening fruit compared

ISSN 0126-4214 (print) ISSN 2527-7162 (online)

with other treatments. Quantitatively, some parameters showed that the gibberellin application resulted in better data. Nevertheless, there is no reference supported the use of gibberellin in duku fruit. Based on a research by Murni *et al*. (2008) conducted on the germination and vegetative growth of duku plants stated that the use of GA_3 100 to 150 ppm was the optimal concentration.

CONCLUSIONS

GA_3 treatment then was considered as the best treatment as it had a unison in fruit maturity, the highest number of fruit per bunch, weight per fruit and total fruit weight per bunch, and had the lowest number of green fruit and seed per fruit.

ACKNOWLEDGEMENT

We would like to express our gratitude to the Director of Research and Community Service of the Directorate General of Higher Education, who has funded this research through the Head of Research Institute of Sriwijaya University with Fundamental Scheme.

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