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

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**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 several plant growth regulators onduku 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 a 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 P1 (BAP 300 mg l-1), P2 (NAA 300 mg l-1), P3 (GA3 300 mg l-1), P4 (BAP 100 mg l-1 + GA3 200 mg l-1), P5 (BAP 200 mg l-1 + GA3 100 mg l-1), P6 (BAP 150 mg l-1 + GA3 150 mg l-1), P7 (NAA 100 mg l-1 + GA3 200 mg l-1), P8 (NAA 200 mg l-1 + GA3 100 mg l-1), P9 (NAA 150 mg l-1 + GA3 150 mg l-1). Spraying was applied twice with a half dosage for each application. The treatment was first sprayed at the flower age of 1 month and the second was 1.5 months after flower formation. Data was analyzed using F test and 5 % of least significance difference. Results showed that plant growth regulator affected duku fruit formation. Single treatment of GA3 with the concentration of 300 mg per liter resulted in relatively similar fruit maturity, the highest number of fruit per bunch, fruit weight per fruit and total fruit weight per bunch, and the lowest number of green fruit and seed per fruit.

Keywords: Auxin, Cytokinin, Duku, Gibberellin.

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**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 was far below the reccomended standard of Food Agricultural Organization (FAO) which was 65 kilograms per capita per year. This number showed that Indonesian people have not consumed enough fruits as the required health standard yet. Besides, it also indicated the potency for the development of domestic fruits to fulfill fruit consumption standard.

Duku (Lansiumdomesticum Corr.) is a tropical seasonal fruit distributed limitedly in Southeast Asia, including Indonesia, Malaysia and China (Lizawatiet al., 2013). The development of local fruit, such as duku, is one of the efforts to increase national fruit production. 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.

One of the famous duku cultivars in Indonesia is Duku Palembang. It is well-known for its sweet taste and thin fruit skin. Government of South Sumatra Province has established duku as a “mascot flora” as it 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 effort to increase duku quality is beneficial, not only to maintain the sweet taste and thin fruit skin, but also as the attempt to produce seedless fruit since seed in duku would be incovenient for consumption.

The use of plant regulator growth in low dosage could trigger either biochemical, physiological or morphological reaction that later would impact the growth, development, and plant movement by either stimulating, inhibiting, or transforming.Research result by Wijayanto et al. (2012) stated that the application of 300 mgL-1 GA3 could decrease the average of seed number from 31.08 to 13.67 in watermelon. The application of GA3 in duku could also affect the germination and vegetative growth. According to Murni et al. (2008), GA3concentration of 100 to 150 ppm was the optimum range for the germination and vegetative growth of duku. Research by Karjadi and Buchrory (2007) on the use of NAA and BAP in garlic tissue culture found out thatleaf number growth and plant height was optimally required in the dosage of 2.5 – 7.5 mgL-1 BAP and 0 mgL-1 NAA. While for root development was obtained in the range of 2.5 mgL-1 NAA and 2.5 mgL-1 BAP.

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

**MATERIALS AND METHODS**

This research was conducted Sijacarana Local Technical Implementation 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 (GA3), 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 P1 (BAP 300 mg L-1 ), P2 (NAA 300 mgL-1), P3 (GA3 300 mg L-1), P4 (BAP 100 mg L-1 + GA3 200 mg L-1 ); P5 (BAP 200 mg L-1 + GA3 100 mg L-1); P6 (BAP 150 mg L-1 + GA3 150 mg L-1); P7 (NAA 100 mg L-1 + GA3 200 mg L-1); P8 (NAA 200 mg L-1 + GA3 100 mg L-1); P9 (NAA 150 mg L-1 + GA3 150 mg L-1).

Duku tree as the replicate was sprayed twice; first at the age of 1 month and 1.5 months since the formation of flowers, each half dose of the treatment. The sprayed flowers were covered with clear plastic for one day to anticipate the effects of rain.After one day the plastic lid was opened. During the blooming growth process was observed until the fruit was ready to harvest. Harvesting was done at the same time for all treatments based on the presence of bunchscontaining ripe fruits.This was carried out 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 the significance difference among treatments was tested using F test with 5 % of least significance difference.

**RESULTS AND DISCUSSION**

The results showed that visually there was a difference on development response of duku fruit after sprayed with plant growth regulator which resulted in the uneven ripening time. The spraying treatment, however, was not performed according to the anthesis time for duku flowerssince the flowers did not bloom during anthesis. Uddin *et al.* (2009)suggested that the plant growth regulator spraying had to be on exact schedule and concentration that it could form the fruit.

Yet, although the spraying exact timing was not known but the results obtained showed that the fruits began to form one week after the second spray in all treatments. However, during their development, although the fruit age was thesame, the ripening time was different (Figure is not shown). This difference of fruit maturity resulted in harvesting at the same time for all treatments. Harvesting criterion was based on earlier ripe fruit, due to the consideration to prevent fruit damage (fruit rupture) and fruit loss.

The development of fruit was observed qualitatively and quantitatively at harvest time. The data obtained were analyzed by using analysis ofvariance.The results showed that the effect of spraying of plant growth regulator significantly effectd all observed variables, i.e. number of fruit buds per bunch, number of fruit per bunch, number of green fruit per bunch, fruit diameter (cm), fruit weight (g), number of seeds per fruit (seed), total fruit weight per bunch (g). The variability coefficient of all parameters ranged from 9.60 to 21.29 percent (Table 1).

Table 1.Analysis of variance of the observed variables

No. Parameter F valueVariability Coefficient(%)

|  |  |  |  |
| --- | --- | --- | --- |
| 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 0.05 2.51

0.01 3.71

Note: \*\* = very significant

The results obtained showed that the highest number of fruit buds per bunch was of treatment P5with 114 fruit buds, which was not significantly different from treatment P1 andP9 but significantly different from other treatments. The lowest number of fruit buds per bunch was treatment P8 with 75 fruit buds, which was significantly different from treatment P1, P5and P9but was not significantly different from other treatments. The data of the number of fruit buds were useful to explain the differences in fruit development. In fact, the number of fruit buds was not counted before spraying, but only after spraying (Figure 1).

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

 (The bar showsstandard deviation; numbers followed by the same letters

 are insignificantly different based onleast significant difference test at α =

 5%)

 Based on the result of the research, 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 (Figure 2). Separately, the lowest number of fruit was obtained in cytokinin treatment, thenit was increased in the auxin treatment and highest in the gibberellin treatment, respectively of 33.67; 35.67 and 61.67. This is in line with the research result on tomato plants by Vermaet al. (2014) which found that 40 ppm of GA3 usage could yield the highest number of fruit compared to other treatments (GA3 20-30 ppm; NAA 15 - 45 ppm and 2.4-D 5-15 ppm). In the same way, for mixed treatment, the number of fruit formed in the mixture of cytokinin and gibberellin was relatively lower than that of auxin andgibberellin. Another research on two varieties of mango plants for two years by Nkansah et al. (2012) found that mango plants sprayed with 25 ppm GA3 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 andgibberellin (P6 = BAP 150 mg L-1 + GA3 150 mg L-1 BAP 150 mg L-1 + GA3 150 mg L-1) or of auxinandgibberellin (P9 = NAA 150 mg L-1 + GA3 150 mg L-1).

 Based on Figure 2, the highest number of fruit in P9 treatment (62.33 fruits) was insignificantly different from P3 treatment (61.67 fruits) and the lowest was in P4 treatment (17 fruits) which was significantly different from other treatments.

Figure 2.The effect of Plant Growth Regulator on Number of Fruit per Bunch

 (The bar showed standard deviation; numbers followed by the same letters

 are insignificantly different based onleast significant difference test at α =

 5%)

Based on data of the number of fruit buds and the number of fruit per bunch, it was obtained the percentageof number of fruit formed from the fruit buds per bunch. The highest percentage of fruits formed was in treatment P3at 65.61 and the lowest was in treatment of P4at 18.68 (Figure 3).This percentage indicates the effect of gibberellin on the fruit formation process compared to other plant growth regulators either by its own or mixed. Masrooret 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.

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

 (The bar showed standard deviation; numbers followed by the same letters

 are insignificantly different based on least significant difference test at α =

 5%)

As the fruit developed differently, the data obtained showed that the lowest number of green fruit per bunchwas in P3treatment at 0.67, which was insignificantly different from P4,although it was at 4.0 in P4 treatment, and had significant difference from other treatments. The highest number of green fruit was in P9 treatment at 23.0 (Figure 4). This condition showed the difference in fruit ripening due to some plant growth regulators spraying (Figure not shown). P3 treatment generated the fastest fruit ripening that caused the lowest number of green fruit per bunch. It was assumed that gibberellineffect 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 GA3 treatment ripened earlier those with auxin.

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

 (The bar showed standard deviation; numbers followed by the same letters

 are insignificantly different based onleast significant difference test at α =

 5%)

The lowest percentage of green fruit compared to formed fruit was obtained in treatment P3 (gibberellin) and the highest was in P7 treatment (NAA 100 mg L-1 + GA3 200 mg L-1) (Figure 5). The low percentage of green fruit compared to formed fruit showed that almost all fruit ripened faster in GA3 treatment than in any other treatments. This is in line with the number of green fruit.

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

 (The bar showed standard deviation; numbers followed by the same letters

 are insignificantly different based onleast significant difference test at α =

 5%)

To understand the effect of plant growth regulators on fruit diameter, it was obtained that the highest fruit diameter was in P1 treatment at 2.89 cm, which was insignificantly different from P6 treatment at 2.86 cm, and significantly different from other treatments (Figure 6). There is no information about the effect of GA3 on duku fruit. As on green fruit percentage, the fruit diameter was also affected by GA3 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 GA3 usage in the early stage of fruit forming yielded in longer fruit compared to the application in blossoming stage.

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

 (The bar showed standard deviation; numbers followed by the same letters

 are insignificantly different based on least significant difference test at α =

 5%)

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 P3 treatment, both variables are significantly different from other treatments. While the lowest fruit weight was obtained by P9 treatment at 8.90 g which was insignificantly different from other treatments except from P3 treatment. On the other hand, the lowest total fruit weight per bunch was obtained byP4 treatment at 164.22 g which was significantly different from other treatments (Figure 7-8). Gelmesa *et al.*(2010) stated that the implementation of GA3 concentration could increase the fruit weight in average of 27% compared to those without GA3 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.

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

 standard deviation; numbers followed by the same lettersare insignificantly

 different based on least significant difference test at α = 5%)

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

 bar showed standard deviation; numbers followed by the same lettersare

 insignificantly different based on least significant difference test at α = 5%)

 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 P3treatment with 1.67 seeds, which insignificantly different from P1, P2 dan P5treatments but significantly different from P4, P6, P7, P8 dan P9 treatments (Figure 9). The highest number of seeds was in P6, P7 and P8treatments with 3.67 seeds. A research on gibberellineffect on decreasing number of seeds had ever conducted by Wijayanto et al. (2012) on watermelon plant. The results showed that the implementation of GA3 300 mg L-1reduced the average number of seeds from 31.08 to 13.67. Another research on tomato plant also showed the application of GA3 with 40 ppm concentration could decrease 9.13% of seeds compared to the controlled groups (Rolistyo et al. 2014; Adnyesuari et al., 2015).

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

(The bar showed standard deviation; numbers followed by the same lettersare insignificantly different based on least significant difference test at α = 5%)

Generally, the data obtained qualitatively and quantitatively of this research from flower development to fruit harvest supported one another. Qualitatively, flowers got P3treatment (300 mg GA3) produced relatively faster and equally ripening fruit compared to other treatments. Qualitatively, it was acquired that flowers with P3treatment (300 mg GA3) produced relatively faster and equally ripening fruit compared 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 dukufuit. Based on a research by Murni *et al.* (2008) conducted on the germination and vegetative growth of duku plants stated that the use of GA3 100 to 150 ppm was the optimal concentration.

**CONCLUSION**

Gibberellinapplication (GA3) with concentration of 300 mg per liter to duku flowers qualitatively resulted in faster and relatively equal ripening fruit, and quantitatively produced the highest percentage of formed fruit and the lowest average of seeds per fruit.

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**REFERENCES**

Adnyesuari, A.A., R.M. Murti dan S.Mitrowihardjo. 2015. Induksi Partenokarpi Pada Tiga Genotipe Tomat denganGA3. Ilmu Pertanian Vol.18 (1) : 56-62

Central Bureau of Statistics, 2015.StatistikProduksiBuah-Buahan di Indonesia. [www.bps.go.id](http://www.bps.go.id) (accessed on June 19, 2016).

Deroes, K,M dan A.Wijaya. 2010. Kondisi kini dan peluang mengembangkan duku (Lansium domesticum Corr.). Jurnal Pembangunan Manusia Vol.4 (11): 1-7, 2010.

Directorate General of Horticulture, 2012. Statistik Hortikultura Tahun 2010 (Angka Tetap) Direktorat Jenderal Hortikultura Departemen Pertanian. Jakarta

Gelmesa, Dandane, Bekele dan Lemma.2010.Effects of Gibberellic acid and 2,4dichlorophenoxyacetic acid spray on fruit yield and quality of Tomato (Lycopersicumesculentum Mill.). Journal of Plant Breeding and Crop Science Vol.2(10): 316-324.

Karjadi, A.K. Buchory, A. 2007. Pengaruh NAA dan BAP terhadap pertumbuhan jaringan meristem bawang putih pada media B5. J. Hort. 17(3):217-223, 2007

Lizawati., B. Ichwan., Gusniwati., Neliyatidan M. Zuhdi. 2013. Fenologipertumbuhanvegetatifdangeneratiftanamandukuvarietaskumpehpadaberbagaiumur. JurnalBioplantae. 2 (1): 16-26.

Masroor, Khan dan Gautam.2006.Effect of Gibberelic Acid Spray on Performance of Tomato. Turk J Biol. 30 (12-13).

Murni, P., D.P. Harjono, Harlis. 2008. Pengaruh asam giberelat (GA3) terhadap perkecambahan dan pertumbuhan vegetatif duku (Lansium dooko Griff.). BiospeciesVol.1 (2) : 63-66, 2008.

Nkansah, G.O., J.Ofosu-Anim and A. Mawuli. 2012. Gibberellic Acid and Naphthalene Acetic Acid Affect fruit Retention, Yield and Quality of Keitt Mangoes in the Coastal Savanna Ecological Zone of Ghana. Am.J.Plant Physiol. 7 (6): 243-251

Permatasari., D.A., Y.S. Rahayu dan E. Ratnasari. 2016. Effect of Giberellin Hormones The Formation of Parthenocarpy Fruit of Tomato Plants Varieties Tomabtu F1. LenteraBio Vol. 5 No. 1, Januari 2016: 25–31

Rolistyo, A., Sunaryo dan T. Wardiyati. 2014. Pengaruh Pemberian Gibberellin terhadap Produktivitas DuaVarietasTanamanTomat (Lycopersicumesculentum mill.). JurnalProduksiTanaman, Volume 2, Nomor 6, September 2014, hlm. 457-463

Wijayanto, T., Wa ode rahziayani, M.W. Arsana. 2012. Responhasildanjumlahbijibuahsemangka (citrullus vulgaris) denganaplikasihormongibberellin (GA3) J.Agroteknos. Vol. 2 (1): 57-62, 2012

Tiwari, A., R. Offringa and Ep Heuvelink. 2012. Auxin-induced Fruit Set in Capsicum annuum L. Requires Downstream Gibberellin Biosynthesis. J. Plant Growth Regul 31:570-578.2012

Yasmin, S., T. Wardiyati., Koesriharti. 2014. Pengaruh perbedaan waktu aplikasi dan konsentrasi gibberellin (GA3) terhadap pertumbuhan dan hasil tanaman cabai besar (*Capsicum annuum* L.). Jurnal Produksi Tanaman Vol. 2(5):395-403, 2014

Yulianto, J.S., D. Juanda. 2008. Kefektifan teknik perangsangan pembungaan pada kelengkeng. J.Hort. Vol. 18 (2): 148-154, 2008.

Uji, T., 2007.Keanekaragamarnjenisbuah-buahanasli Indonesia danpotensinya.Biodiversitas 8 (2) : 157-167.

Uddin, J., K.M. Akhter Hossain, M.G. Mostafa dan M.J. Rahman.2009. Effect of Different Plant Growth Regulators on Growth and Yield of Tomato.Internationald Journal of Sustainable Agriculture 1 (3) pp 58- 63.

Verma, P.P.S., M.L. Meena and S.K. Meena. 2014. Effect of Plant Growth Regulators on Growth, Flowering and Quality of Tomato (LycopersiconEsculentum Mill), cv. H-86. Indian Journal of Hill Farming 27(2):19-22