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The Effect of Difference Soaking Duration and GA_3 Concentration on Germination of oil Palm (*Elaeis Guineensis* Jacq)

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Abstract. One of the main oil palm seed dormancy factors is the shell thickness. This could influence the germination homogeneity and required more time for oil palm seeds to germinate evenly. There will be such alternatives to improve oil palm seed germination as shell-less oil palm seeds or *kernels* which were soaked at different duration time and GA_3 concentration. The objectives of this research was to evaluate germination rate of *kernels* under different soaking time and GA_3 concentration. This study was conducted on Laboratory Plants Seed and Breeding, College of Agriculture, University of Lampung from June 2019 to September 2019. Treatment was arranged by factorial (6x3) in a randomized completely block design (RCBD) with 3 replications. The first factors were the six different concentrations of GA_3 hormones as 0, 100, 200, 300, 400, and 500 ppm. The second factors were the three different soaking duration as 3, 7, and 10 days. The variables observed were the percentage of germination, the maximum growth potential, early time of germination, germination rate, dormancy intensity, radicle and plumule lengths. The data were analyzed by analysis of variance and then different mean values of treatments were analyzed by 5% of LSD using the SAS software application (version 9.4). The results showed that the concentration of 200 ppm GA_3 resulting in low dormancy intensity (12.22%), increasing potency maximum growth (87.78%), and kernels germination rate (8.44%/etmal) compared with a concentration of 0 ppm GA_3. Soaking duration of GA_3 10 days resulted in low dormancy intensity (17.22%), the percentage of germination increased (23.33%), the maximum growth potential increased (78.89%), the kernel germination rate (8.94%/etmal), radicle length (2.00cm), plumule length (1.92cm), and early time of germination (4.61days) compared to the length of soaking duration of 3 days.
Keywords: GA_3, germination rate, kernels, soaking time

1. Introduction

Naturally, oil palm seeds need longer time to germinate approximately 6-12 months from early germination process until the end of seed germination time. The more oil palm seeds were stored before germination process, the less seeds would germinate. The fresh oil palm seeds without storing, the germination percentage was around 55.4% and would reduce to be 38.7% when the seeds were stored for 6 months [1]. The long storage of oil palm seeds could cause the deleterious seeds resulted to low germination percentage or damaged seeds. One of the main causes for oil palm seeds to germinate is seed dormancy.

Mechanical seeds treatment by cracking oil palm seed shell hopefully could shorten the

germination time and might increase the germination percentage. The technique of germination of oil palm by dry treatment at a temperature of 20 to 22°C resulted in a germination percentage 70% in six weeks germination room [3]. According to [4], the treatment of cracking the oil palm shell to be kernel was able to shorten the emergence of germination as 3.3 days after germination. Based on this, breaking the shell is able to eliminate palm oil dormancy.

The breaking the oil palm shell is expected to make the *kernel* permeable to water and oxygen. The long soaking treatment can stimulate the absorption of water into the seeds more quickly [5]. The results of [6], the soaking *Calopogonium careuleum* seeds for 24 hours with GA_3 of 500 ppm concentration resulted in a germination percentage of 57.33% higher compared with other soaking period with GA_3 concentrations. The research [7] resulted, the duration of soaking oil palm seeds for 7 days increased germination rate 19.63% higher compared with other soaking period. This shows that the longer the soaking is done, the higher the sprouts obtained. This is in line with [8], the time it takes for seeds to imbibe is quite varied, starting from one hour to close to two weeks to germinate.

The GA_3 hormone plays a major role in the germination process through the activity of producing enzymes and transporting food reserves. The results of [9], showed that the application of 200 ppm GA_3 can increased *Veichia merili* seed germination percentage of 60.33%, and The soaking time of 72 hours in seeds *Veitchia merili* increased germination percentage 54.13%. The soaking oil palm seeds with GA_3 at a concentration of 200 ppm resulted in a sprout percentage of 46.67% [10]. According to [11], giving GA_3 with high concentrations is more optimal in breaking dormancy of seeds that have hard skins. This was supported by [12], soaking GA_3 in 500 ppm concentration of *Asparagus cyclophyllum* seeds resulted in the highest percentage of germination of 81% compared to other GA_3. According to [13], GA_3 are growth regulators that could eliminate dormancy in the seed coat and stimulate germination. The objective was to evaluate germination rate of *kernels* under different soaking times and GA_3 concentration.

2. Material and Methods

This study was conducted on Laboratory Plants Seed and Breeding, College of Agriculture, University of Lampung from June 2019 to September 2019. The physiological maturity of seed bunch was harvested then seed depericarping process was manually conducted to pill mesocarp out. Seeds with shell was put in oven 40°C for a week resulted in empty space between kernel and shell. This condition caused easily to pill shell out by manual pressing machine to get kernel. After this, kernels were soaked by solution of thiram 80% as initial seed treatment for three hours and then these kernels were air dried. Treatments were arranged by a single factor in randomized completely block design (RCBD) with three replications. The first factor were the three different soaking durations as 3, 7, and 10 days. The second factor were three different concentration of GA_3 hormones as 0, 100, 200, 300, 400, and 500 ppm. The data were analysed by analysis of variance when showed a significant difference then the different mean values of treatments were analysed by 5% of LSD using SAS software application (Version 9.4).

The variables observed this research were germination percentage (GP), maximum growth potential (MGP), early germination time (EGT), radicle length (RL), plumule length (PL), germination rate (GR_{CT}), dormancy intensity (DI).

$$\text{Germination Percentage } (GP) = \frac{\sum normal\ germination}{\sum total\ kernels} \text{ x } 100\% \quad (1)$$

$$\text{Maximum Growth Percentage}(MGP) = \frac{\sum normal\ germination + \sum abnormal\ germination}{\sum total\ kernels} \text{ x } 100\% \quad (2)$$

GR_{CT} was calculated based on sum of normal germination every 10 days starting from 10 days until 60 days then divided by etmal of the day (GR_{CT}), 1 etmal = 24 hours. Normal germination percentage was calculating at 10, 20, 30, 40, 50, and 60 days after germination with formula

$$GR_{CT} = \frac{\%\,NG-10}{Etmal\ 10} + \frac{\%\,NG-20}{Etmal\ 20} + \frac{\%\,NG-30}{Etmal\ 30} + \frac{\%\,NG-40}{Etmal\ 40} + \frac{\%\,NG-50}{Etmal\ 50} + \frac{\%\,NG-60}{Etmal\ 60} \quad (3)$$

Note:
GR_{CT} = Germination rate (%/etmal)
NG = Normal Germination (%) [14]

DI was calculated according to [15], who measuring DI from seeds which not germinate or growth until the end of observation with formula:

$$DI = \frac{The\ kernel\ is\ not\ germination}{\sum Total\ kernels} \text{ X } 100\% \quad (4)$$

Radicle Length (RL) and Plumule Length (PL) were measured using a ruler after 60 days after plants.

3. Result and Discussion

Table 1 shows that he concentration of GA_3 could induce the variation of all variables observed except for GP and EGT. Moreover, all variables observed showed variation except for radicle length (RL) and plumula length (PL) due to soaking time. These variations meant that there were differences of mean values of treatments.

Table 1. The mean square value of variables on kernels (*Elaeis guineensis* Jacq.)

Variable	Soaking time (ST)	[GA_3] (GC)	ST*GC	CV (%)
Germination Percentage (GP)	496,3*	269,63^{ns}	136,3^{ns}	63,74
Max Growth Pot. (MGP)	846,3**	1185,18**	157,41^{ns}	15,57
Early Germination Time (EGT)	8,13**	7,32^{ns}	4,49^{ns}	34,68
Radicle Length (RL)	0,41^{ns}	0,61**	0,23^{ns}	21,63
Plumula Length (PL)	0,31^{ns}	0,56**	0,19^{ns}	20,28
Germination Rate (GR)	13,69**	10,21**	1,53^{ns}	15
Dormancy Intensity (DI)	846,3**	1185,2**	157,41^{ns}	52,26

Note : * & ** = Significant at 5% & 1% level; ns = not significant ; GC = GA_3 Concentration, ST*GC = Soaking time * GA_3 concentration, CV : Coefficient of Variance

Table. 2 shows that the application of 0 ppm GA_3 gave the lowest MGP, as 55.56%, the slowest GR, as 6.22%/etmal, and the highest DI, as 44.44%. On the other hand, the application of 200 ppm GA_3 with resulted in the optimum of MGP, as 87.78% but low DI, as 12.22%.

Table 2. Effect of GA_3 concentration on maximum growth potential (MGP), germination rate (GR), and dormancy intensity (DI)

GA_3 (ppm)	MGP (%)	GR (%/etmal)	DI (%)
0	55.56 c	6.22 b	44.44 a
100	75.56 b	8.22 a	24.44 b
200	87.78 a	8.44 a	12.22 c
300	76.67 ab	8.44 a	23.33 bc
400	83.33 ab	9.11 a	16.67 bc
500	83.33 ab	9.11 a	16.67 bc
LSD 5%	11.49	1.19	11.5

Note :The mean values followed by different letters in the same column indicate a significant difference in the mean value at the LSD 5%.

Table 3 shows that the application of 0 ppm GA_3 gave the shortest RL and PL, as 1.49 cm and 1.41 cm. On the other hand, the application of 200 ppm GA_3 resulted of RL and PL, as 2 cm and 1,92 cm, but it has no different from the application of 300 ppm, 400 ppm and 500 ppm GA_3.

Table 3. Effect of GA_3 concentration on radicle length (RL) and plumule length (PL)

GA_3 (ppm)	RL (cm)		PL (cm)	
	Origin	trans $\sqrt[0,25]{X}+1$	Origin	trans $\sqrt[0,25]{X}+1$
0	0,76	1,49 b	0,50	1,41 b
100	1,42	1,87 ab	1,01	1,82 a
200	1,97	2,00 a	1,39	1,92 a
300	2,52	2,24 a	1,84	2,13 a
400	2,24	2,10 a	1,59	2,01 a
500	1,78	2,03 a	1,23	1,94 a
LSD 5%		0,41		0,36

Note: different numbers in the same column followed by different letters indicate a significant difference in the mean value at the LSD 5%. The data analyzed is data that has been transformed $\sqrt[0,25]{X}+1$

This study was supported by [11], soaking oil palm seeds with GA_3 at a concentration of 200 ppm resulted in a sprout percentage of 46.67%. The application of 200 ppm GA_3 increased germination to palm *kernels* is thought be optimal in stimulating cell growth and ensuring that the *kernels* germinates fast. This was supported by [16], GA_3 was able to increase the GP of the embryo and overcome the inhibition caused by the seed cover layer. The application of 200 ppm GA_3 increased germination percentage to Catuai variety arabica coffee around 59%. On the other hand, the application of 200 ppm and 300 ppm GA_3 gave roots longer, as 3.77 cm and 3.70 cm. The application of 200 ppm GA_3 increased germination of intermediate wheatgrass twelve days after seeding, as 93.33% [17].

According to [18] research, the application of GA_3 to be 200 ppm concentration produce the highest *Veitcchia merili* seeds germination percentage of 60.33%. The effect for application of GA_3 solution early germination of *Osmorhiza claytonii* seeds. The low DI by application of 200 ppm GA_3 could increase the germination rate. According to [19], GA_3 stimulates cells elongation, due to amylase hydrolysis process which is activated by giberellic acid. This is in accordance with [20], the application of GA_3 is able to overcome seed dormancy and stimulate the synthesis, activation,

secretion of hydrolytic enzymes, especially amylase, mainly α-amylase, releasing reducing sugars and amino acids which are essential for embryo growth in germination. According to [21], the combination of period soaking and the application of GA_3 has a real effect on the germination of soursop seeds, this is because the absorption of water by soursop seeds is fast so that the excitatory power of GA_3 is able to provide good physiological response by producing normal germinations. Giving GA_3 250 ppm concentrations result corrected germination rate index in *Thrinax morrisii* 82.51% compared GA_3 100 ppm and 500 ppm concentrations, as 74.89% and 68.12% [22].

According to the results of [12], the applications of GA_3 in various concentrations starting from 0 ppm, 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm was able to increased germination percentage of *Astragalus cyclophyllon* seeds starting from 55% to 81%. Seeds of *Astragalus cyclophyllon* did not show any favorable reaction to low concentrations of GA_3, because of their high rate of dormancy, but increased with higher concentrations of GA_3 ≥300 ppm. This is due to the fact that GA_3 treatment has the ability to speed up the process of imbibition to increase the fat reserves that serve the embryo during germination [13].

Table 4. Effect of GA_3 soaking time on germination percentage (GP), maximum growth potential (MGP), early germination time (EGT), germination rate (GR), and dormancy intensity (DI)

Soaking time GA_3 (days)	GP (%)	MGP (%)	EGT (days)	GR (%/etmal)	DI (%)
3	13.3 b	69.4 b	8.83 a	7.28 b	30.6 a
7	15.6 b	78.9 a	6.33 b	8.56 a	21.1 b
10	23.3 a	82.8 a	4.61 c	8.94 a	17.2 b
BNT 5%	7.52	8.13	1.55	0.84	8.13

Note : The mean values followed by different letters in the same column indicate a significant difference in the mean value at the LSD 5%.

Table. 4 shows that the soaking time of 3 days GA_3 gave the lowest GP and MGP, as 13.3% and 69,4%, the slowest EGT and GR, as 8.83 days and 7.28%/etmal, and the highest DI, as 30.6%. On the other hand, the soaking time of 10 days GA_3 with resulted in the optimum of GP and EGT, as 23.3% and 4.61 days, but low DI, as 17.2%.

The longer the kernels were soaked then the water that enters the seed more and more. The mechanical scarification and water soaking effectively broke the physical dormancy of freshly collected doum palm seeds [23]. Germination rate for seeds soaked in water for 24 hour was slightly higher as 68.02% than the control as 62.15% of *Sabal palmetto* [22]. This is in line with [24], the longer the seeds were soaked, the process of imbibition becomes quickly characterized by increased seed moisture content so as to facilitating the germination process. The treatment of soaking oil palm seeds water significantly affected the germination percentage, as 41.6%. It is suspected that the longer the seeds are soaked, the faster the imbibition process is indicated by increased in the moisture content of the seeds so as facilitate the germinantion process.

The longer the seed is soaked with GA_3, the more GA_3 accumulates in the seed cell. Provision of GA_3 as a growth regulator substances can stimulate cell division [25]. Furthermore, there is an interaction between exogenous GA_3, endogenous GA_3, and water. Water will effectively GA_3 which can increase the activity of division and lengthening of cells [26]. GA_3 soaking period for 3 days is suspected to be unable to break dormancy and the kernel has not been able to absorb water properly, so the water content in the kernel is not met causing the germination process to be hampered. This is in line with [27], the water content needed by palm seeds in the germination process is 22-24% The results of [28], soaking teak seeds for 9 days with atonic solution resulted in faster germination of 5 days after germination compared to 6 days of soaking 10.67 days after germination.

4. Conclusion

It could be proven that 200 ppm GA_3 resulted in low dormancy intensity (12.22%), increased maximum growth potential (87.78%), radicle length (2.00 cm), plumule length (1.92 cm), and fastened kernel. germinated rate (8.44%/etmal) compared to without GA_3. Moreover, low dormancy intensity (17.22%) was resulted from soaking GA_3 for 10 days led to increased germination percentage (23.33%), maximum growth potential.

5. Acknowledgements

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