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RESPONSE OF GA_3 SOAKING CONCENTRATION TO THE VIABILITY AND VIGOR OF SEEDS OF TWO VARIETIES OF PAPAYA (*CARICA PAPAYA* L.)

RESPON KONSENTRASI PERENDAMAN GA_3 TERHADAP VIABILITAS DAN VIGOR BENIH DUA VARIETAS PEPAYA (*CARICA PAPAYA* L.)

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Abstract

The purpose of this study was to determine the effect of the comparison of soaking concentrations of GA $_3$ on the viability and vigor of seeds of two varieties of papaya. The experiment was carried out in the laboratory and screen house of the Food Crops and Horticulture Seed Supervision and Certification Center (BPSBTPH) of the Food Crops and Horticulture Service, Jawa Barat Province, Bojongsoang, Bandung Regency, at an altitude of 630 m above sea levels from April to May 2023. The design used was an environmental design using a two-factor Split Plot Design which was repeated three times. The first factor as the main plot was the variety consisting of two stages including v_1 (Callina variety) and v_2 (PY ASA 01 variety). The second factor as a plot for comparison of GA_3 concentrations contained 5 levels including k_0 (0 mgL^{-1} water), k_1 (50 mgL^{-1} water), k_2 (100 mgL^{-1} water), k_3 (150 mgL^{-1} water), k_4 (200 mgL^{-1} water). The experimental results showed an interaction between soaking concentration of GA_3 and variations in germination rate, germination rate, root length, plant vitality, and plant dry weight, but no interaction occurred on germination time, plant height, stem diameter, number of leaves, root volume and the extinction ratio. Root (NPA). Testing the immersion concentration of GA_3 150 mgL^{-1} on the Callina variety gave better growth in germination power, germination speed, root length, plant fresh weight, and plant dry weight compared to the PY ASA 01 variety. Independently the variety only had a higher root volume effect on the Callina variety offspring of the PY ASA 01 variety. Meanwhile, the soaking concentration of GA_3 affected stem diameter, root volume, and NPA. GA_3 immersion concentration of 150 mgL^{-1} water produced the highest stem diameter, root volume, and NPA. Application of the optimum soaking concentration of GA_3 for the Callina variety of 141.87 mgL^{-1} water resulted in a maximum dry weight of 0.8274 grams, while the optimum soaking concentration of GA_3 for PY ASA 01 of 150.5 mgL^{-1} water resulted in a maximum dry weight of 0.610 grams.

Keywords: *GA_3 , papaya, Callina Variety, PSY ASA 01 Variety, viability and seed vigor*

Abstrak

Tujuan penelitian ini mengetahui pengaruh perbandingan konsentrasi perendaman GA_3 terhadap viabilitas dan vigor benih dua varietas pepaya. Percobaan dilaksanakan di laboratorium dan screen house Balai Pengawasan dan Sertifikasi Benih Tanaman Pangan dan Hortikultura (BPSBTPH) Dinas Tanaman Pangan dan Hortikultura Provinsi Jawa Barat, Bojongsoang Kabupaten Bandung dengan ketinggian 630 m di atas permukaan laut pada April sampai Mei 2023. Rancangan yang digunakan adalah rancangan lingkungan menggunakan Rancangan Acak Petak Terbagi (*Split Plot Design*) dua faktor yang diulang tiga kali. Faktor pertama sebagai petak utama adalah varietas terdiri dari dua tarap meliputi v_1 (Varietas Callina) dan v_2 (Varietas PY ASA 01). Faktor kedua sebagai anak petak perbandingan konsentrasi GA_3 terdiri dari 5 taraf meliputi k_0 (0 mgL^{-1} air), k_1 (50 mgL^{-1} air ^{1}), k_2 (100 mgL^{-1} air), k_3 (150 mgL^{-1} air), k_4 (200 mgL^{-1} air). Hasil percobaan menunjukkan terjadi interaksi antara konsentrasi perendaman GA_3 dan varietas terhadap daya berkecambah, kecepatan berkecambah, panjang akar, bobot segar tanaman dan bobot kering tanaman, tetapi tidak terjadi interaksi terhadap waktu berkecambah, tinggi tanaman, diameter batang, jumlah daun, volume akar dan Nisbah Pupus Akar (NPA). Pengujian konsentrasi perendaman GA_3 150 mgL^{-1}air pada varietas Callina memberikan pertumbuhan daya berkecambah, kecepatan berkecambah, panjang akar, bobot segar tanaman dan bobot kering tanaman yang lebih baik dibandingkan varietas PY ASA 01. Secara mandiri varietas hanya berpengaruh terhadap volume akar varietas Callina lebih tinggi dibandingkan varietas PY ASA 01, sedangkan konsentrasi perendaman GA_3 berpengaruh terhadap diameter batang, volume akar dan Nisbah Pupus Akar (NPA). Konsentrasi perendaman GA_3 150 mgL^{-1} air menghasilkan diameter batang, volume akar dan NPA tertinggi. Aplikasi konsentrasi perendaman GA_3 optimum untuk Varietas Callina sebesar 141,87 mgL^{-1} air menghasilkan bobot kering maksimum sebesar 0,8274 gram, sedangkan konsentrasi perendaman GA_3 optimum untuk PY ASA 01 sebesar 150,5 mgL^{-1} air menghasilkan bobot kering maksimum sebesar 0,610 gram.

Kata kunci : GA_3, pepaya, Varietas Callina, Varietas PSY ASA 01, viabilitas, dan vigor benih

INTRODUCTION

Sarcotesta in papaya seeds is a clear skin layer which is a phenolic compound that can be removed by washing or soaking. Cleaning the sarcotesta generally cannot be very clean, there is still sarcotesta left behind and attached to the seed which acts as an inhibitor or barrier to seed germination and dormancy. For this reason, efforts are needed to break papaya seed dormancy so that it is hoped that it can increase seed germination and improve papaya seed vigor.

Generally, soaking the growth medium with a GA_3 solution concentration of 0.05% can break the dormancy level. For a weak seed dormancy level, a concentration of 0.02% is expected to be sufficient, and if the dormancy is stronger, a concentration of 0.1% or more can be used (Mustikayukti *et al.*, 2021). Soaking with GA_3 can promote seed germination and post-germination growth and restore developmental defects caused by phytohormone deficiency (Xiong *et al.*, 2021). For this reason, so that papaya seeds can grow quickly simultaneously, efforts are made to use the growth regulator GA_3 which plays a large role in influencing various plant physiological processes because it can increase the growth potential of the embryo and can

also act as a germination promoter and overcome mechanical obstacles caused by the covering layer of the seed and phytohormone deficiency defects.

RESEARCH METHODS

The research was carried out using experimental methods through experiments in the laboratory and screen house of the Food Crop and Horticulture Seed Supervision and Certification Center (BPSBTPH) of the West Java Province Food Crop and Horticulture Service, Jl. Ciganitri II Bojongsoang, Bandung Regency. The altitude of the experimental location is 630 meters above sea level. The experiment will be carried out from May to July 2023. The materials used in this experiment consisted of seeds of the national superior papaya plant, Calina variety, PY ASA 01 variety known as Dampit variety, straw paper, plastic testing box, measuring cup, measuring pipette, Erlenmeyer, GA_3 solution, sterile sand. The tools used in this experiment include analytical scales, plastic measuring cup boxes, Erlenmeyer, measuring pipettes, thermohygrometers, hand prayers, embraces, calipers, and rulers.

The variables in the experiment consist of independent variables and related variables. The independent variables consist of Variety; which consists of two levels of Variety (V), two levels, namely: v_1 = Callina Variety and v_2 = PY ASA 01 Variety; and the immersion concentration of GA_3 consists of five levels, namely: k_0 = 0 mgL^{-1} water, k_1 = 50 mgL^{-1} water, k_2 = 100 mgL^{-1} water, k_3 = 150 mgL^{1} water and k_4 = 200 mgL^{-1} water. The environmental design uses a Random Split Plot Design. Variety is the main plot and the comparison of GA_3 immersion concentrations is a subplot. The observation parameters consist of seed viability variables, namely: germination power, germination speed, and germination time (wb); Seed vigor is: plant height, stem diameter, number of leaves, root length, root volume, plant fresh weight, plant dry weight, root loss ratio (NPA).

RESULTS AND DISCUSSION

The results of the analysis of germination power and seed germination speed, it turns out that there is an interaction between GA_3 soaking and papaya varieties on seed germination and germination speed, the results of simple effect tests can be seen in Tables 1 and 2.

From Tables 1 and 2, there is an interaction between the application of the comparison of GA_3 soaking concentration and variety on the viability of germination and the speed of germination of papaya seeds. This is due to the concentration of 150 mgL^{-1} water able to have a better influence on the germination of papaya seeds of Callina and PSY ASA 01 varieties. This is by the opinion of (Pertiwi, M; Tahir, M; Made, 2016), that in this phase GA_3 ican control the synthesis of hydrolytic enzymes in germination. seed. Sugar compounds and amino acids, soluble substances produced by amylase and protease activity are transferred to the embryo to support embryo development and the emergence of sprouts. Then obey Widjayati *et al*., (2017), there is a breakdown of food reserves and mobilization to the growing point which is regulated by GA $_3$ so that it diffuses through the endosperm to the aleurone layer. However, by increasing the

soaking concentration of GA_3, the ratio becomes 200 mgL^{-1} of water for the two papaya varieties, which will hamper the growth and speed of germination of plant seeds. This is because excess GA_3 can inhibit growth (Setyati, 2019).

Table 1. Effect of GA_3 Concentration and Variety on Germination of Papaya Seeds 28 (DAP)

$_3$ concentration	Germination Power (%)	
	v_1 (Callina)	v_2 (PY ASA 01)
k_0 (0 mgL^{-1} water)	60.00 a B	30.00 a A
k_1 (50 mgL^{-1} water)	68.67 b B	31.67 a A
k_2 (100 mgL^{-1} water)	80.33 c B	56.33 c A
k_3 (150 mgL^{-1} water)	81.33 c B	76.67 d A
k_4 (200 mgL^{-1} water)	70.67 b B	44.67 b A

Note: The average treatment figures marked with the same letter in each column (lowercase letters) and each row (capital letters) are not significantly different according to the Least Significant Difference Test at a significance level of 5%.

Table 2. Effect of GA_3 Concentration and Variety on Germination Speed of Papaya Seeds

GA_3 concentration	Germination Speed (%/etmal)	
	v_1 (Callina)	v_2 (PY ASA 01)
k_0 (0 mgL^{-1} water)	28.33 a B	26.60 a A
k_1 (50 mgL^{-1} water)	29.03 b B	26.60 a A
k_2 (100 mgL^{-1} water)	29.90 c B	28.07 c A
k_3 (150 mgL^{-1} water)	29.90 c B	29.00 d A
k_4 (200 mgL^{-1} water)	29.27 b B	27.37 b A

Note: The average treatment figures marked with the same letter in each column (lowercase letters) and each row (capital letters) are not significantly different according to the Least Significant Difference Test at a significance level of 5%.

The concentration of GA_3 soaking given can increase the percentage of germination. This is thought to be because the function of GA_3 can accelerate germination and stimulate vegetative growth. Seed growth rate is a measure of plant growth. Seeds that grow quickly will be better able to cope with sub-optimal field conditions and can compete with weeds (Widjayati *et al.*, 2017). According to (Setyati, 2019), seeds with good viability and fast seed growth are very important. Based on Ministry of Agriculture Decree Number 42 (2019), concerning Horticultural Seed Certification, papaya seeds that germinate >70% are seeds that have good viability and

vigor. The results of germination power or seed growth power can be used to predict the potential for seed growth in the field. The results of the analysis of germination time due to GA_3 soaking concentration and papaya varieties showed that there was no interaction between GA_3 soaking and papaya varieties, the results of the independent effect test can be seen in Table 3.

Table 3. Effect of GA_3 Concentration and Variety on Germination Time of Papaya Seeds

TREATMENT		Germination Time (days)
Main Plot:	Papaya varieties	
v_1	(Callina)	16.0800 a
v_2	(PY ASA 01)	19,1200 a
Subplots:	GA_3 immersion concentration	
k_0	(0 mgL $^{-1}$ water)	18.4667 a
k_1	(50 mgL $^{-1}$ water)	17.6167 a
k_2	(100 mgL $^{-1}$ water)	18,2000 a
k_3	(150 mgL $^{-1}$ water)	16.6333 a
k_4	(200 mgL $^{-1}$ water)	17.0833 a

Note: The average number of treatments followed by the same letter in the column direction is not significantly different according to the Least Significant Difference Test at the five percent significance level.

Independently, the application of the comparison of GA_3 concentration and varieties had no significant effect on germination time (Table 3), this shows that the use of GA_3 can break dormancy in papaya seeds because GA_3 is a hormone that can accelerate germination, although statistically the effect is not significant, this is possible because the germination time is very tight so that the increase in germination time has no significant effect. According to (Widjayati *et al*., 2017), the way GA_3 works in seed germination begins with the occurrence of water imbibition stimulating gibberellin synthesis, then the gibberellin diffuses into the aleurone layer and stimulates enzyme synthesis. The results of the analysis of plant height and number of leaves due to the concentration of GA_3 immersion and papaya varieties showed that there was no interaction between GA_3 immersion and papaya varieties on papaya plant height 28 dap, and number of leaves 28 dap. The results of the independent effect test can be seen in Table 4.

Table 4. Effect of GA_3 Concentration and Variety on Plant Height and Number of Leaves Papaya 28 DAP.

TREATMENT		Plant height 28 hst. (cm)	Number of Leaves 28 dap (pieces)
Main Plot:	Papaya varieties		
v_1	(Callina)	6.4787 a	4.93 a
v_2	(PY ASA 01)	6.3960 a	4.95 a
Subplots:	GA_3 immersion concentration		
k_0	(0 mgL^{-1} water)	6.2433 a	4.87 a
k_1	(50 mgL^{-1} water)	6,3000 a	4.97 a
k_2	(100 mgL^{-1} water)	6.6467 a	4.87 a
k_3	(150 mgL^{-1} water)	6.6433 a	5.07 a
k_4	(200 mgL^{-1} water)	6.3533 a	4.93 a

Note: The average number of treatments followed by the same letter in the column direction is not significantly different according to the Least Significant Difference Test at the five percent significance level.

Effect of application of GA_3 immersion concentration and variety has no significant effect on plant height and number of leaves (Table 4), this is thought to be in line with the increasing concentration of GA_3-containing molecules that can influence plant height and number of leaves as well as the better the condition around the plant will be. increasing the growth of plant roots which function as a medium for the entry of nutrients into the plant; However, it is due to the growth phase plant is still very young so Plant growth and plant height and number of visible leaves are not real. In further growth, it is hoped that if GA_3 is provided, the higher N that can be utilized will have an impact on higher plant growth, especially on plant height and number of leaves. According to Setyati (2019), the effect of GA_3 is used for biological assays and has broad effects on many developmental processes, especially those controlled by temperature and light (photoperiod); including plant and seed dormancy, germination, vegetative to generative growth stalk development. Results of analysis of plant stem diameter 28 (DAP) due to GA_3 immersion concentration and papaya varieties there was no interaction between GA_3 soaking and papaya varieties, the results of independent effect testing can be seen in Table 5.

Table 5. Effect of GA_3 Concentration and Variety on Stem Diameter, Root Volume and Ratio Root Pudding (NPA) of Papaya Plants 28 DAP.

Treatment		Bar Diameter (mm)	Root Volume (ml)	Root Loss Ratio (NPA)
Main Plot:	Papaya varieties			
v_1	(Callina)	1.55 a	0.4420 b	2.0463 a
v_2	(PY ASA 01)	1.56 a	0.3200 a	2.0549 a
Subplots:	GA_3 immersion concentration			
k_0	(0 mgL^{-1}water)	1.46 a	0.3050 a	1.6274 a
k_1	(50 mgL^{-1} water)	1.50 a	0.3500 a b	1.7689 a
k_2	(100 mgL^{-1} water)	1.54 a	0.3917 b	1.9659 ab
k_3	(150 mgL^{-1} water)	1.73 a	0.4750 c	2.6720 c
k_4	(200 mgL^{-1} water)	1.54 a	0.3833 a b	2.2187 b

Note: The average number of treatments followed by the same letter in the column direction is not significantly different according to the Least Significant Difference Test at the five percent significance level.

The independent effect of the application of the comparison of GA_3 concentration and varieties significantly affected the diameter, root volume, and Root Destruction Ratio (NPA) (Table 5), it is suspected that the growth of stem diameter, root volume, and NPA depends on the growth of the crown. If the growth of the plant crown is inhibited, plant growth in this case the stem diameter, root volume, and NPA will also be inhibited. According to Setyati (2019), the growing point and central axis, namely the stem, support the leaves that produce plant food and connect them to the roots that

collect water and nutrients. This shows that the process of accumulating assimilation results in the sink (leaves or stems) is followed by better growth of the lower part of the plant. Results of analysis of plant root length (cm) due to GA_3 immersion concentration and papaya varieties, it turns out that there is an interaction between GA_3 soaking and papaya varieties, the results of the simple effect test can be seen in Table 6.

Table 6. Effect of GA_3 Concentration and Variety on Plant Root Length 28 DAP.

GA_3 Concentration	Root Length (cm)			
	v_1 (Callina)		v_2 (PY ASA 01)	
k_0 (0 mgL^{-1} water)	11.63	a	10.53	a
	A		A	
k_1 (50 mgL^{-1} water)	14.20	b	13,13	b
	A		A	
k_2 (100 mgL^{-1} water)	14,10	b	15.70	c
	A		B	
k_3 (150 mgL^{-1} water)	17.97	d	16.10	c
	B		A	
k_4 (200 mgL^{-1} water)	16,13	c	13.63	b
	B		A	

Note: The average treatment figures marked with the same letter in each column (lowercase letters) and each row (capital letters) are not significantly different according to the Least Significant Difference Test at a significance level of 5%.

Table 6 shows the length of plant roots at a GA concentration level of GA_3 0 mgL^{-1} water and 50 mgL^{-1} water the level of the Callina variety was not significantly different from the PY ASA 01 variety; while at a concentration of 100 mgL^{-1} water, 150 mgL^{-1} water and 200 mgL^{-1} water the level of the Callina variety is significantly different from the PY ASA 01 variety. Giving GA_3 concentration of 150 mgL^{-1} water gave the highest plant root length results in the Callina Variety and PY ASA 01 Variety. Meanwhile, GA_3 was given a concentration of 0 mgL^{-1} water the Callina and PY ASA 01 varieties gave the lowest plant root length compared to other concentrations. Results of analysis of plant fresh weight (grams) due to GA_3 immersion concentration and papaya varieties, it turns out that there is an interaction between GA_3 soaking and papaya varieties, the results of the simple effect test can be seen in Table 7.

Table 7. Effect of GA_3 Concentration and Variety on Plant Fresh Weight

GA_3 Concentration	Plant Fresh Weight (grams)			
	v_1 (Callina)		v_2 (PY ASA 01)	
k_0 (0 mgL^{-1} water)	0.7	a	0.66	a
	B		A	
k_1 (50 mg^{-1} water)	0.92	b	0.7	b
	B		A	
k_2 (100 mgL^{-1} water)	0.97	c	0.82	c
	B		A	
k_3 (150 mgL^{-1} water)	1.16	e	0.94	e
	B		A	
k_4 (200 mgL^{-1} water)	1.02	d	0.92	d
	B		A	

Note: The average treatment figures marked with the same letter in each column (lowercase letters) and each row (capital letters) are not significantly different according to the Least Significant Difference Test at a significance level of 5%.

Table 7 shows the administration of GA_3 concentration of 150 mgL^{-1} water gave the highest NPA results on the Callina Variety and PY ASA 01 Variety. Meanwhile, GA_3 was given a concentration of 0 mgL^{-1} water the Callina and PY ASA 01 varieties provide the lowest NPA compared to other concentrations. Results of analysis of plant dry weight due to GA_3 immersion concentration and papaya varieties, it turns out that there is an interaction between GA_3 soaking and papaya varieties, the results of the simple effect test can be seen in Table 8.

Table 8. Effect of GA_3 Concentration and Variety on Plant Dry Weight

GA_3 Concentration	Plant Dry Weight 28 hst. (grams)	
	v_1 (Callina)	v_2 (PY ASA 01)
k_0 (0 mgL^{-1})	0.22 a A	0.20 a A
k_1 (50 mgL^{-1})	0.55 b B	0.43 b A
k_2 (100 mgL^{-1})	0.74 d B	0.55 c A
k_3 (150 mgL^{-1})	0.88 e B	0.63 d A
k_4 (200 mgL^{-1})	0.70 c B	0.56 c A

Note: The average treatment figures marked with the same letter in each column (lowercase letters) and each row (capital letters) are not significantly different according to the Least Significant Difference Test at a significance level of 5%.

Table 8 shows that giving GA_3 at a concentration of 150 mgL^{-1} water gave the highest dry plant weight results for the Callina variety and the PY ASA 01 variety. Meanwhile, GA_3 was given a concentration of 0 mgL^{-1} water the Callina and PY ASA 01 varieties provide plant dry weight lowest compared to other concentrations.

There was an interaction between the application of GA_3 soaking concentration and variety on root length (Table 6), plant fresh weight (Table 7), and plant dry weight (Table 8). It is suspected that there is an increase in GA_3 application, indicating that the number of cells and their enlargement are in good condition. Increased cell division causes an increase in the number of cells which increases plant growth such as root length, wet weight, and dry weight. In the plant life phase, plant freshness is related to water content, evaporation rate, and photosynthesis rate. The higher the plant water content the lower the evaporation rate, and the higher the life phase. GA_3 soaking treatment of 150 mgL^{-1} water can increase the phase of life. According to Setyati, (2019), a plant makes new cells, elongates these cells, and thickens the tissues, actually developing the stem, leaves, and root system. If the rate of cell division and elongation as well as tissue formation is fast, the growth of stems, leaves, and roots also runs fast. The regression analysis to determine the optimum GA_3 concentration which provides the maximum dry weight for each variety stage, can be seen in Table 9.

Table 9. Quadratic Regression Equations and Determination Coefficients for Two Papaya Seed Varieties

Variety	Regression Equations	Coefficient of Determination
Callina	$Y v_1 = 0.2032 + 0.0087 X - 3.100.E-05 X^2$	$R^2 = 0.9649$
PS ASA 01	$Y v_2 = 0.1994 + 0.0054 X - 1.811 E-05 X^2$	$R^2 = 0.9855.$

Based on the results of the dry weight regression analysis of the plant, the optimum X of the Callina variety of 141.87 mgL^{-1} water gave a dry weight of 0.8274 grams; while the optimum X of the PY ASA 01 variety of 150.5 mgL^{-1} water gave a maximum dry weight of 0.610 grams. The results of the Callina optimum X were lower than the optimum X of PY ASA 01 but gave a higher dry weight than PY ASA 01. This is suspected that the Callina variety is more optimal in controlling the synthesis of hydrolytic enzymes in seed germination to support embryo development and the emergence of sprouts and growth differentiation. According to (Lakitan, 2018) if GA_3 is given at the right concentration it can be beneficial for plants. Giving GA_3 stimulates plant metabolic activity so that cell differentiation activities increase and the process of tissue growth and development increases. The relationship between plant dry weight and GA_3 concentration immersion can be seen in Figure 1.

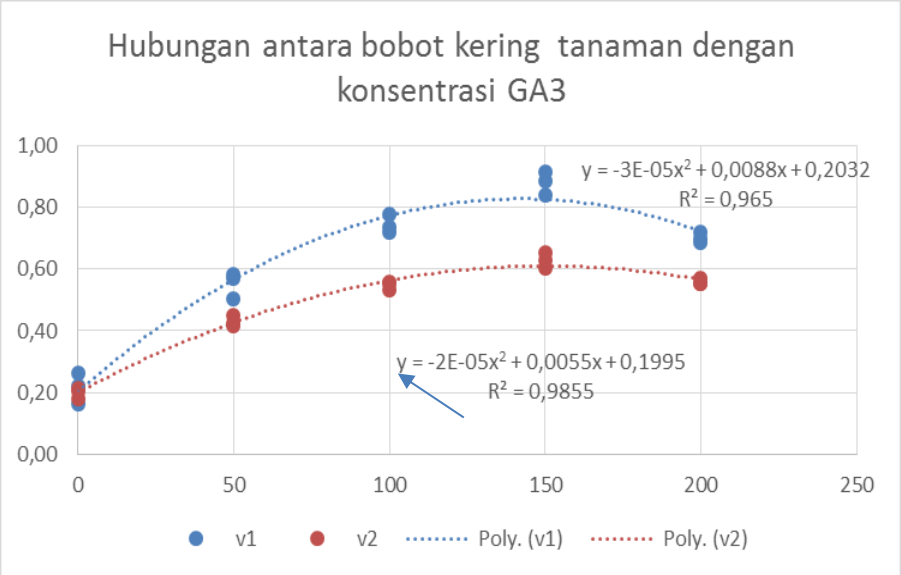

Figure 1. Relationship between plant dry weight and GA_3 Concentration

CONCLUSION

There was an interaction between the concentration of GA_3 immersion and varieties on germination power, germination speed, root length, fresh weight of plants, and dry weight of plants, but there was no interaction on germination time, plant height, stem diameter, number of leaves, root volume and Root Depletion Ratio (NPA). Testing the concentration of GA_3 immersion of 150 mgL^{-1} water on the Callina variety provided better growth in germination

power, germination speed, root length, fresh weight of plants, and dry weight of plants compared to the PY ASA 01 variety. Independently, the variety only affected the root volume of the Callina variety which was higher than the PY ASA 01 variety. While the concentration of GA_3 immersion affected the stem diameter, root volume and NPA, the application of GA_3 immersion concentration of 150 mgL^{-1} water produced the highest stem diameter, root volume, and NPA. The application of optimum GA3 soaking concentration for the Callina variety of 141.87 mgL^{-1} water produced a maximum dry weight of 0.8274 grams, while the optimum GA3 soaking concentration for PY ASA 01 of 150.5 mgL^{-1} water produced a maximum dry weight of 0.610 grams.

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