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Effects of NAA and GA_3 at Different Concentrations on Growth and Quality of Oil Palm Bunch and Fruit (*Elaeis guineensis* Jacq.)

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Effect of NAA and GA_3 on at different concentrations on growth and quality of oil palm bunch and fruit were investigated. The experiment was conducted in oil palm garden, Plant Science Department, Faculty of Agriculture, Rajamangala University of Technology Srivijaya, Nakhon Si Thammarat Campus,Thailand from September, 2015 to May, 2016. The experimental design was used the 2x6 factorial experiment in completely randomized design (CRD), consisted of 2 factors : factor 1 was two kinds of plant growth regulator, naphthalene acetic acid (NAA) and gibberellic acid (GA_3), and factor 2 was applied six concentrations of each plant growth regulator as 0 100 200 300 400 and 500 ppm. The result showed that the effect of GA_3 at 200-300 ppm significant differed in average of fruit width, fruit length, fruit weight and bunch weight among the treatments and control. NAA at 100-200 ppm, showed a significant difference in average of fruit width, fruit length, fruit weight and bunch weight among the treatments and control. The effect between GA_3 and NAA on the fruit width, GA_3 it was shown more effective than NAA, but NAA was shown more affected in fruit width, fruit weight and bunch weight than GA_3. GA_3 and NAA were applied at the difference concentrations to the young fruits of oil palm, resulted to no affected in percent of fruit set, dry mesocarp per fruit ,oil per dry mesocarp and oil per bunch.

Keyword : NAA, GA_3, oil palm, fruit growth and development

Introduction

The oil palm (*Elaeis guineensis* Jacq.) is a commercially important crop of the world with a production of palm oil in the year 2014/2015 of 61.63 million tons, the world largest of palm oil production is Indonesia 33.00 million tons, the second palm oil production is Malaysia 19.88 million tons, the both countries had been 84.46 percent of palm oil production of the world and the

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third palm oil production is Thailand 2.10 million tons. (Office of Agricultural Economics, 2016). The cultivation area of oil palm production in Thailand 722,500 million hectares.During the year 2014 to 2016, the trend of oil palm production in Thailand was increased of plantation area due to the low cost of capital per area it is lower than other crops and the price of the oil palm bunch is high. This cause is motivated to the oil palm smallholder to increase the plantation area (Office of Agricultural Economics, 2015). The synthetic and natural plant bioregulators used extensively for the improvement of crop performance in citrus (Agusti *et al*., 1994 ; Elfving and Cline, 1993a, 1993b ; Autio and Green, 1994), blackberry (Rom, 1999), sweet cherry (Facteau *et al*., 1992) and avocado (Garcia and Lovatt, 2000). Many scientists studied the effect of some growth regulators on yield and fruit quality of date fruit. Application of gibberellic acid in combination with hand pollination increased fruit set percentage, pulp/seed ratio, average fruit weight and size (Ibrahim and Simbel, 1991). The objective of this study was to investigate the effects of naphthalene acetic acid (NAA) and gibberellic acid (GA_3) at the different concentrations on growth and quality of oil palm bunch and fruit.

Materials and methods

Plant materials

The experiment was conducted at the palm garden of Plant Science Department, Faculty of Agriculture, Rajamangala University of Technology Srivijaya, Nakhon Si Thammarat Campus, Thailand. Eight-year–old fieldgrown oil palm trees were used in this study from September, 2015 to May, 2016. Plants under investigation were grown in the same location and were subject to rigorously similar cultural practices.

Treatments

2x6 factorial in completely randomized design (CRD) with single tree plots replicated five times was used. The treatments compose with 2 factors : factor 1 were used two kinds of plant growth regulator, NAA and GA_3, and factor 2 were used six concentrations of each plant growth regulator are 0 100 200 300 400 and 500 ppm, spray to the bunch of young oil palm fruit.

Data recording and analysis

For very month were collected the fruit width (cm), fruit length (cm), fruit weight (g) and at the harvesting time were collected the bunch weight (kg) of oil palm fruits and percent of fruit set, dry mesocarp per fruit (%),oil per dry

mesocarp (%) and oil per bunch (%) at the harvesting time. The data analysis was used program-R and treatment means were statistically compared using Duncan's Multiple Range Test (DMRT).

Results

Effect of GA_3 and NAA at the difference concentrations on fruit growth and development

The effect of GA_3 at the different concentrations on the fruit growth and development, there was showed a significant difference in average of fruit width (cm) among the treatments, after GA_3 spraying at 30 days the concentration 200 and 300 ppm provided the highest of average fruit width were 1.76 and 1.38 cm, after GA_3 spraying at 60 days the concentration 200 ppm provided the highest of average fruit width was 1.92 cm, after GA_3 spraying at 90 days the concentration 200 and 100 were 2.25 and 1.99 cm and after GA_3 spraying at 120 days the concentration 200 and 100 ppm provided the highest of average fruit width were 3.00 and 2.93 cm (Table 1 and 2).

The average of fruit length (cm) among the treatments, after GA_3 spraying at 30 days the concentration 200 and 300 ppm provided the highest of average fruit length were 3.20 and 2.92 cm, after GA_3 spraying at 60 days the concentration 200 and 300 ppm provided the highest of average fruit length were 4.39 and 3.87 cm, after GA_3 spraying at 90 days the concentration 200, 100 and 300 ppm provided the highest of average fruit length were 3.96 3.68 and 3.66 cm and after GA_3 spraying at 120 days the concentration 200 and 100 ppm provided the highest of average fruit length were 4.18 and 3.86 cm (Table 1,2).

The average of fruit weight(g) among the treatments, after GA_3 spraying at 30 days the concentration 200 ppm provided the highest of average fruit weight were 4.42 g, after GA_3 spraying at 60 days the concentration 200 ppm provided the highest of average fruit weight was 7.92 g, after GA_3 spraying at 90 days the concentration 200 ppm provided the highest of average fruit weight were 8.44 g and after GA_3 spraying at 120 days the concentration 200 ppm provided the highest of average fruit weight was 12.77 g (Table 1 and 2).

The effect of NAA at the different concentrations on the fruit growth and development, there was showed a significant difference in average of fruit width (cm) among the treatments, after NAA spraying at 30 days the concentration 200 and 300 ppm provided the highest of average fruit width were 1.47 and 1.42 cm, after NAA spraying at 60 days the concentration 100 and 200 ppm provided the highest of average fruit width were 1.83 and 1.62 cm, after NAA spraying at 90 days the concentration 100 and 200 were 2.16 and1.93 cm and after NAA spraying at 120 days the concentration 100 and 200

ppm provided the highest of average fruit width were 2.24 and 2.16 cm (Table 1 and 2).

The average of fruit length (cm) among the treatments, after NAA spraying at 30 days the concentration 100-500 ppm and control provided the average fruit length were not significant 2.62 4.43 2.36 2.24 2.22 and 2.19 cm, respectively, after NAA spraying at 60 days the concentration 100 and 200 ppm, there was showed a significant difference in average of fruit length, there provided the highest of average fruit length were 4.02 and 3.52 cm, after NAA spraying at 90 days the concentration 100 200 300 and 400 ppm provided the highest of average fruit length were 3.86 3.80 3.68 and 3.66 cm,respectively, and after NAA spraying at 120 days the concentration 100 200 300and 400 ppm provided the highest of average fruit length were 3.92 3.87 3.85 and 3.58 cm, respectively (Table 1 and 2).

The average of fruit weight (g) among the treatments, after NAA spraying at 30 days the concentration 100 200 and 300 ppm provided the highest of average fruit weight were 2.99 2.80 and 2.65 g, after NAA spraying at 60 days the concentration 100 ppm provided the highest of average fruit weight was 7.44 g, after NAA spraying at 90 days the concentration 100 ppm provided the highest of average fruit weight was 9.21 g and after NAA spraying at 120 days the concentration 100 200 300 400 and 500 ppm provided the highest of average fruit weight were 10.83 10.28 9.31 8.24 and 7.93 g, respectively (Table 1 and 2).

Effect of NAA and GA_3 at the difference concentrations on bunch weight

The effect of GA_3 at the different concentrations on the bunch weight (kg), there was showed a significant difference in average of bunch weight among the treatments, after GA_3 spraying at 120 days the concentration 200 300 and 400 ppm provided the highest of average bunch weight were 14.30 12.30 and 11.60 kg. The effect of NAA at the different concentrations on the bunch weight (kg), there was showed a significant difference in average of bunch weight among the treatments, after GA_3 spraying at 120 days the concentration 100 200 300 and 400 ppm provided the highest of average bunch weight were 16.96 12.30 11.20 and 10.93 kg, respectively (Table 2).

Effect between GA_3 and NAA on fruit growth and development

The effect between GA_3 and NAA on the fruit width (cm) after spraying at 30 days, there was showed not significant difference in average of fruit width among the treatments were 1.35 and 1.38 cm, after spraying at 60 days, there was showed not significant difference in average of fruit width

among the treatments were 1.82 and 1.85 cm. after spraying at 90 days, there was showed a not significant difference in average of fruit width among the treatments were 1.74 and 1.75 cm, after spraying at 120 days, there was showed a significant difference in average of fruit width among the treatments were 2.56 and 2.72 cm (Table 1 and 2).

The effect between GA_3 and NAA on the fruit length (cm) after spraying at 30 days, there was showed a significant difference in average of fruit length among the treatments were 2.64 and 2.34 cm, after spraying at 60 days, there was showed a not significant difference in average of fruit length among the treatments were 3.72 and 3.40 cm. after spraying at 90 days, there was showed not significant difference in average of fruit length among the treatments were 3.89 and 3.60 cm, after spraying at 120 days, there was showed a significant difference in average of fruit length among the treatments were 3.97 and 3.71 cm (Table 1 and 2).

The effect between GA_3 and NAA on the fruit weight (g) after spraying at 30 days, there was showed not significant difference in average of fruit weight among the treatments were 2.75 and 2.92 g, after spraying at 60 days, there was showed not significant difference in average of fruit weight among the treatments were 5.77 and 5.89 cm. after spraying at 90 days, there was showed not significant difference in average of fruit weight among the treatments were 6.32 and 6.01 cm, after spraying at 120 days, there was showed a significant difference in average of fruit weight among the treatments were 8.12 and 9.73 cm (Table 1 and 2).

The effect between GA_3 and NAA on the fruit bunch (kg) after spraying at 120 days, there was showed significant difference in average of fruit weight among the treatments were 11.73 and 12.90 kg, (Table 2).

Effect of GA_3 and NAA on percent of fruit set, dry mesocarp per fruit, oil per dry mesocarp and oil per bunch at the harvesting time

The effect of GA_3 at the different concentrations on percent of fruit set, dry mesocarp per fruit, oil per dry mesocarp and oil per bunch at the harvesting time, there was showed not significant difference in average among the treatments of percent of fruit set, dry mesocarp per fruit, oil per dry mesocarp and oil per bunch and also effect of GA_3 and NAA on percent of fruit set, dry mesocarp per fruit, oil per dry mesocarp and oil per bunch at the harvesting time, there was showed not significant difference in average among the treatments of percent of fruit set, dry mesocarp per fruit, oil per dry mesocarp and oil per bunch (Table 2).

Table 1. Effect of GA_3 and NAA on fruit width, fruit length, fruit weight of oil palm at 30 and 60 days.

Treatments (GA_3)	30 days			60 days		
	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)
Control	1.19b	1.95d	2.32c	1.29d	3.35b	3.58b
100 ppm	1.23b	2.28c	2.53bc	1.83b	3.57b	5.76b
200 ppm	1.76a	3.20a	4.42a	1.92a	4.39a	7.92a
300 ppm	1.38ab	2.92ab	3.48b	1.76b	3.87ab	5.27bc
400 ppm	1.21b	2.77b	2.67bc	1.44c	3.71b	4.47b
500 ppm	1.31b	2.73b	2.61bc	1.42c	3.44b	3.83b
F-test	*	**	*	**	*	*
CV (%)	17.10	6.54	16.95	5.16	8.17	16.20
Treatments (NAA)	30 days			60 days		
	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)
Control	1.21b	2.19	1.12b	1.26c	3.21b	4.14c
100 ppm	1.57b	2.62	2.99a	1.83a	4.02a	7.44a
200 ppm	1.47ab	2.43	2.80a	1.62ab	3.52ab	6.29b
300 ppm	1.42ab	2.36	2.65a	1.48b	3.44b	5.17bc
400 ppm	1.33b	2.24	1.40b	1.57b	3.35b	5.01c
500 ppm	1.27b	2.22	1.34b	1.43b	3.31b	4.79c
F-test	*	ns	*	*	*	*
CV (%)	9.77	11.73	20.60	18.87	8.31	11.95
Treatments	30 days			60 days		
	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)
GA_3	1.35	2.64a	2.75	1.82	3.82a	5.77
NAA	1.38	2.34b	2.92	1.85	3.47b	5.89
F-test	ns	*	ns	ns	*	ns
CV (%)	13.82	9.23	16.65	14.65	8.21	10.79

Mean values with each column followed by a same letter are not significantly at $p \leq 0.05$ tested by DMRT

Table 2. Effect of GA_3 and NAA on fruit width, fruit length, fruit weight of oil palm at 90 and 120 days.

Treatments (GA_3)	90 days			120 days			
	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Bunch weight (kg)
Control	1.46c	3.25b	3.33d	2.33b	3.41b	3.00d	8.40b
100 ppm	1.99a	3.68ab	3.91cd	2.93a	3.86ab	3.67d	9.54bc
200 ppm	2.25a	3.96a	8.44a	3.00a	4.18a	12.77a	14.30a
300 ppm	1.71b	3.66ab	6.06b	2.71b	3.73b	7.56b	12.30ab
400 ppm	1.69b	3.47b	5.13bc	2.52b	3.54b	5.74c	11.60ab
500 ppm	1.66b	3.45b	5.01bc	2.49b	3.51b	3.96d	10.93bc
F-test	*	*	*	*	*	*	*
CV (%)	10.66	6.88	12.82	18.31	11.68	12.48	13.13
Treatments (NAA)	90 days			120 days			
	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Bunch weight (kg)
Control	1.62b	3.31b	3.77b	1.62b	2.56c	5.51b	8.45b
100 ppm	2.16a	3.86a	9.21a	2.21a	3.92a	10.83a	16.96a
200 ppm	1.93ab	3.80ab	7.11a	2.16a	3.87ab	10.28a	12.30ab
300 ppm	1.80ab	3.68ab	5.15b	2.10a	3.85abc	9.31a	11.20ab
400 ppm	1.71ab	3.66ab	5.06b	2.05ab	3.582abc	8.24ab	10.93ab
500 ppm	1.71ab	3.41b	4.91b	1.87ab	2.75bc	7.93ab	10.60b
F-test	**	*	*	*	*	*	*
CV (%)	13.93	7.88	13.65	12.24	15.44	17.23	14.15
Treatments	90 days			120 days			
	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Bunch weight (kg)
GA_3	1.74	3.69a	6.01	2.56b	3.68a	8.12b	11.73a
NAA	1.75	3.60b	6.32	2.72a	3.47b	9.73a	12.70b
F-test	ns	*	ns	*	*	*	*s
CV (%)	8.74	6.18	13.72	16.37	15.38	12.46	16.32

Mean values with each column followed by a same letter are not significantly at $p \leq 0.05$ tested by DMRT

Table 3. Effect of GA_3 and NAA on percent of fruit set, dry mesocarp per fruit (%),oil per dry mesocarp (%) and oil per bunch(%) at the harvesting time.

Treatments	percent of fruit set (%)	dry mesocarp per fruit (%)	oil per dry mesocarp (%)	oil per bunch (%)
Control	71.30	59.30	68.70	25.70
100 ppm	72.01	61.70	69.10	25.20
200 ppm	71.50	58.60	74.10	26.30
300 ppm	71.80	59.20	72.10	24.80
400 ppm	72.30	58.80	69.40	25.30
500 ppm	71.10	60.45	70.03	26.40
F-test	ns	ns	*	ns
CV (%)	10.66	13.11	12.82	8.31
Treatments	percent of fruit set (%)	dry mesocarp per fruit (%)	oil per dry mesocarp (%)	oil per bunch (%)
Control	71.30	59.30	68.70	25.70
100 ppm	72.01	61.70	69.10	25.20
200 ppm	71.50	58.60	74.10	26.30
300 ppm	71.80	59.20	72.10	24.80
400 ppm	72.30	58.80	69.40	25.30
500 ppm	71.10	60.45	70.03	26.40
F-test	ns	ns	*	ns
CV (%)	10.66	13.11	12.82	8.31
Treatment	percent of fruit set (%)	Dry mesocarp per fruit (%)	oil per dry mesocarp (%)	oil per bunch (%)
GA_3	72.21	60.70	70.89	25.40
NAA	72.54	60.62	70.56	25.56
F-test	ns	ns	ns	ns
CV (%)	10.11	7.10	10.72	10.37

Mean values with each column followed by a same letter are not significantly at $p \leq 0.05$ tested by DMRT

Discussion

Many scientists studied the effect of some growth regulators on yield and fruit quality of date fruit. Application of gibberellic acid in combination with hand pollination increased fruit set percentage, pulp/seed ratio, average fruit weight and size (Ibrahim and Simbel, 1991). Naphthalene acetic acid application on date palm trees increased fruit weight, dimensions, flesh weight percentage and total soluble solid percentage and reduced fruit ripening (%) (Moustafa, Seif and Abou-El-Azayem, 1993). The same result of this experiment, gibberellic (GA_3) and Naphthalene acetic acid (NAA) was effected to fruit growth in tern of fruit width, fruit length, fruit weight of oil palm,

especially, GA_3 more effected of fruit length than NAA, but NAA it was more effected of fruit width and fruit weight than GA_3, in this cause it was showed the effected NAA on bunch weight than GA_3. The results of NAA application were in agreement with Aljuburi *et al*. (2000) was reported the effect of Naphthalene acetic acid treatment increased significantly fruit weight (kg/bunch) during first and second growing seasons of Barhee date palm trees relative to the control. Application of mixture of growth regulators on flower clusters increased significantly fruit weight (kg/bunch) during the second growing season. Spraying GA3on Khaniezy flower clusters reduced significantly. Effect of gibberellic acid (GA3), naphthalene acetic acid (NAA), ethephon and mixture of growth regulators on fruit ripening (%), fruit weight (kg)/bunch and yield (Kg)/tree of Khaniezy date palm trees during 1994, 1995 and 1996. This experiment were applied of gibberellic acid (GA3), naphthalene acetic acid (NAA) at the difference concentration on fruit set of oil palm it was showed no of percent of fruit set, dry mesocarp perfruit (%),oil per dry mesocarp(%) and oil per bunch (%) Table 3.The oil per bunch of this experiment it was showed higher valued of standard data (25-25%), but oil per dry mesocarp it was showed lower valued data (75%) Malaysia Palm Oil Board (2017).

Conclusion

The result showed that the effect of GA_3 at 200-300 ppm, there was shown the highest effected on width, fruit length , fruit weight and bunch weight than other treatments and control. NAA at 100-200 ppm, there was shown the highest effected on width, fruit length , fruit weight and bunch weight than other treatments and control. The effect between GA_3 and NAA on the fruit lenght, GA_3 it was shown more effected than NAA, but NAA it was shown more effected no fruit width, fruit weight and bunch weight more than GA_3. Gibberellic acid (GA3) and naphthalene acetic acid (NAA) were not effected of fruit quality in term of percent of fruit set, dry mesocarp per fruit ,oil per dry mesocarp and oil per bunch.

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