

**EFFECT OF PLANT GROWTH REGULATORS ON FRUIT
GROWTH AND QUALITY DEVELOPMENT OF *SYZYGIUM
SAMARANGENSE* (WATER APPLE/WAX APPLE)**

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ABSTRACT

The present study was conducted to investigate the effects of Gibberellic Acid (GA_3), Naphthalene Acetic Acid (NAA) and N-2-chloro-4-pyridyl-N-phenylurea (CPPU) on the growth and quality development of water apple/ wax apple (*Syzygium samarangense*). GA_3 at the concentrations of 0 (water control) 30, 60 and 90 ppm was used in experiment 1. NAA at the concentrations of 0 (water control), 6, 12 and 18 ppm was used in experiment 2. CPPU at the concentrations of 0 (water control) 10, 15 and 20 ppm was used in experiment 3. The swabbing technique of hormone application was used for all plant growth regulator applications in the three experiments. The growth regulators at different concentration levels (GA_3 , NAA and CPPU) were applied once a week starting from bud formation stage to flower opening stage (blooming), of twelve year old trees.

In the GA_3 experiments, it was observed that application of GA_3 (30, 60 and 90 ppm) increased fruit length and diameter. Fruit length and diameter proved to be highest in GA_3 at 60 ppm (60 mg/l). Furthermore, it increased the rate of fruit growth and maturity (represented by color) development in addition to increasing fruit number, weight and yield. Premature fruit drop was observed to have declined. With regard to fruit quality, the application of GA_3 at 60 ppm increased the TSS, inverted sugar, fructose and total flavonoid content in wax apple. In addition, anthocyanin, potassium (K^+) and total phenol content were higher in GA_3 treated fruit than control fruit. From these experiments it can be concluded that swabbing 60 ppm (60 mg/l) of GA_3 produced better performance in terms of size, yield and quality of wax apple fruit.

In the NAA treated experiments, bud number was highest in 12 ppm NAA treated branch compared to other NAA treated and control branches. Bud drop decreased with decreasing NAA concentrations. Lowest fruit drop occurred in fruits treated with 12 ppm NAA. Fruit length and diameter were greatly enhanced at the

different concentrations of NAA used. Yield and fruit weight had also significantly increased when 12 ppm NAA was used per branch. The chlorophyll content was also higher in 12 ppm NAA treated leaves than in control leaves. Similarly potassium and total flavonoid content, TSS, sucrose and fructose were also highest in 12 ppm NAA treated fruits. It was also observed that the anthocyanin content and pH value were highest in 12 ppm NAA. From this experiment it can be concluded that the swabbing application of 12 ppm (12 mg/l) NAA showed the best effects on fruit length, set, size and biochemical quality in wax apple fruits.

In the CPPU treated experiments, higher bud drop was observed in 15 ppm CPPU than in the control fruit. Fruit length, diameter, per fruit weight and yield were observed to be higher in 15 ppm CPPU compared with the control. The highest increment in TSS content was recorded in 15 ppm CPPU treated-fruit. Similarly, the highest pH value was observed in 15 ppm CPPU treated fruits. Chlorophyll content was highest in 15 ppm CPPU treated-leaves. The results showed that the pH value, and the potassium content were higher in 15 ppm CPPU treated compared to those of the control fruit. The highest flavonoid, total phenolic and fructose content were recorded in 15 ppm CPPU concentration. Sucrose was also higher in 15 ppm CPPU than in other treatments. From this experiment it can be concluded that the swabbing application of 15 ppm (15 mg/l) CPPU showed the best effects on the fruit size and biochemical quality of the wax apple.

Overall this study has shown that the plant growth regulators at different concentrations (60 ppm GA₃, 12 ppm NAA and 15 ppm CPPU) applied using the swabbing technique greatly improved fruit growth and quality, when applied a week during bud initiation.

ABSTRAK

Kajian ini dijalankan untuk mengenalpasti kesan asid gibberelik (GA_3), asid naphthalen asetik (NAA) dan N-2-chloro-4-pyridyl-N-phenylurea (CPPU) ke atas tumbesaran dan kualiti perkembangan jambu air / jambu lilin (epal air/epal lilin) (*Syzygium samarangense*). GA_3 pada kepekatan 0 (kawalan air), 30, 60 dan 90 ppm digunakan untuk eksperimen 1. NAA pada kepekatan 0 (kawalan air), 6, 12 dan 18 ppm digunakan untuk eksperimen 2. CPPU pada kepekatan 0 (kawalan air), 10, 15 dan 20 ppm digunakan untuk eksperimen 3. Hormon-hormon ini diaplikasikan pada tumbuhan dengan menggunakan teknik sapuan. Hormon pertumbuhan pada kepekatan yang berbeza diaplikasikan sekali seminggu bermula dari peringkat pembentukan kuduk bunga hingga kepada penghasilan bunga kembang pada pokok yang berusia 12 tahun.

Dalam eksperimen yang menggunakan GA_3 didapati pertambahan panjang buah dan diameter apabila hormon ini diaplikasikan. Panjang buah dan diameter adalah paling optimum dalam GA_3 pada kepekatan 60 ppm (60 mg/l). Selain daripada itu, ia juga meningkatkan kadar tumbesaran buah dan kematangannya (dari segi perubahan warna), bilangan buah, berat dan hasil kutipan. Berlaku juga pengurangan dalam keguguran buah belum matang. Dari sudut kualiti buah, penggunaan GA_3 pada kepekatan 60 ppm meningkatkan nilai TSS, gula 'inverted', fruktosa dan jumlah kandungan flavonoid dalam jambu air. Tambahan pula, kandungan antosianin, kalium (K^+) dan jumlah kandungan phenol adalah lebih tinggi dalam buah yang dirawat dengan GA_3 berbanding kawalan. Daripada eksperimen ini dapat disimpulkan bahawa sapuan 60 ppm (60 mg/l) GA_3 telah menghasilkan buah jambu air/epal lilin yang lebih baik dari segi saiz, hasil kutipan dan kualiti.

Pemerhatian terhadap cabang pokok yang dirawat dengan NAA mendapati, bilangan kudup paling banyak pada cabang yang dirawat dengan 12 ppm NAA berbanding kepekatan lain dan kawalan. Bilangan kudup gugur semakin berkurang dengan pengurangan kepekatan NAA. Bilangan buah gugur paling sedikit dalam buah yang dirawat dengan 12 ppm NAA. Panjang buah dan lebarnya semakin bertambah dengan penggunaan kepekatan NAA yang berbeza. Hasil kutipan dan berat buah turut meningkat apabila cabang dirawat dengan 12 ppm NAA. Kandungan klorofil juga adalah tinggi dalam daun yang dirawat dengan 12 ppm NAA berbanding daun kawalan. Kandungan kalium (potassium), jumlah kandungan flavonoid, TSS, sukrosa dan fruktosa adalah paling tinggi dalam buah yang dirawat dengan 12 ppm NAA. Pemerhatian juga menunjukkan kandungan antosianin dan nilai pH adalah paling tinggi dalam 12 ppm NAA. Kesimpulan daripada eksperimen ini mendapati aplikasi secara sapuan 12 ppm NAA menunjukkan kesan terbaik untuk panjang buah, set, saiz dan kualiti biokimia dalam buah epal lilin atau jambu air ini.

Dalam eksperimen menggunakan CPPU, kadar kudup/tunas gugur adalah paling tinggi dalam pokok yang dirawat dengan 15 ppm CPPU berbanding pokok kawalan. Panjang buah, diameter, berat buah dan hasil kutipan adalah lebih tinggi dalam pokok yang dirawat dengan 15 ppm CPPU berbanding pokok kawalan. Peningkatan kandungan TSS, sukrosa, flavonoid, jumlah phenolik, kalium (potassium) dan fruktosa adalah paling tinggi direkodkan dalam buah yang dirawat dengan 15 ppm CPPU. Pemerhatian yang sama juga diperoleh untuk nilai pH, kandungan klorofil dan potassium tertinggi dalam 15 ppm CPPU berbanding kawalan. Kesimpulannya, aplikasi 15 ppm (15 mg/l) CPPU menunjukkan kesan terbaik ke atas saiz buah dan kualiti biokimia buah jambu air/epal lilin ini.

Secara keseluruhan, penyelidikan ini menunjukkan penggunaan hormon penggalak pertumbuhan (tumbesaran) pada kepekatan yang berbeza (60 ppm GA₃, 12 ppm NAA dan 15 ppm CPPU) apabila diaplikasi seminggu semasa pertumbuhan pucuk atau tunas menggunakan teknik sapuan dapat meningkatkan pertumbuhan buah dan kualitinya.

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LIST OF SYMBOLS AND ABBREVIATIONS

ACC-synthase	1-Amino-Cyclopropane-1-Carboxylic acid synthase
1MCP	1-MethylCycloPropene
BA	6-Benzyl-Aminopurine
ABA	ABscissic Acid
AMP	Adenosine MonoPhosphate
ATP	Adenosine-5'-TriphosPhate
AFB	After Full Bloom
AVG	AminoethoxyVinylGlycine
ARR4	Arabidopsis thaliana Response Regulator
AsA	Ascorbic Acid
AtDBP1	DNA Binding Protein
axr1-3 and axr2-1	Auxin mutants
BASF	chemical company : Baden Aniline and Soda Factory
CA	CatecholAmines
CRD	Completely Rendomized Design
CDK	Cyclin-Dependent protein Kinase
CCC	Cycocel
DNA	DeoxyriboNucleic Acid
CPPU	N-(2-Chloro-4-Pyridyl)-N-Phenyl-Urea
FC	Folin-Ciocalteau
FAA	Free Amino Acids
GA, GAs, GAn (n=1, 2,..)	Gibberellic Acid
ICK1	INHIBITORs/INTERACTORs OF CDK
IAA	Indole-3-Acetic Acid
KNOX	KNOTTED1-LIKE HOMEBOX protein

1MCP	1-MethylCycloPropene
mRNA	Messenger RNA
ML	Milliliter
Mm	Millimetre
NAAm	Naphthalene AcetAmide
NAA	Naphthalene Acetic acid
NADPH	Nicotinamide Adenine Dinucleotide Phosphate
PBRs	Plant Bioregulators
K ⁺	Potassium
Pro-Ca	Prohexadione-Calcium
PDR	Prominent Drop control
prz1-1	Proporz
RNA	Ribonucleic Acid
SAM	Shoot Apical Meristem
SAG12	Senescence Associated Gene promoter
DNOC	Sodium Dinitro-Ortho Cresylate
SPAD	Soil Plant Analysis Development
SP	Soluble Protein
SSs	Soluble Solids
SS	Soluble Sugars
TA	Titratable Acids
TPC	Total Phenolic Compounds
TSS	Total Soluble Solid
Z	Zeatin
ZR	Zeatin Riboside
ZOG	Zeatin-O-Glucoside