GENETIC VARIATION AND PERFORMANCE OF SENEGAL OIL PALM (*Elaeis guineensis* Jacq.) NATURAL POPULATIONS

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ABSTRACT

GENETIC VARIATION AND PERFORMANCE OF SENEGAL OIL PALM (*Elaeis guineensis* Jacq.) NATURAL POPULATIONS

Genetic studies were carried out on oil palm germplasm originating from Senegal that was collected by Malaysian Palm Oil Board (MPOB) formerly known as PORIM in 1993. A random sample of five families from each of the 13 sites (populations) was collected to provide information on differences between populations, families and palms. The germplasm was planted at MPOB Kluang, Johor in June 1996. Independent Completely Randomized Design (ICRD) with two replicates was used to evaluate a total of 415 palms in trial 0.352. The materials were evaluated for the bunch yield, bunch quality, vegetative and physiological traits. The objectives of the study were to determine the performance and the genetic structure of the natural populations, the genetic variability among the progenies, to determine the heritability and to study the phenotypic correlations among all the traits. Due to missing values and deceased palms, only 358 palms were evaluated on 35 traits. Analysis of variance (ANOVA) of nine populations showed significant variation for most of the traits except for kernel to fruit (K/F), kernel to bunch (K/B) and leaf area ratio (LAR). ANOVA of 14 progenies showed significant difference for most of the traits at $(P \leq 0.01)$. Broad-sense heritability (h^2_B) estimated for bunch yield and its components where h^2_B = 40-60%. As for bunch quality traits, heritability estimated were low to medium (h^2_B < 50%), the lowest h^2_B of 10% for mesocarp to fruit (M/F) and the highest h^2_B of 46% for oil yield (OY). For vegetative traits, heritability estimated were h^2_B < 65% except for frond production (FP) with the lowest h^2_B of 12%. Physiological traits had higher heritability values of 40-60%. Fresh fruit bunch (FFB) had significant positive correlation, (r = 0.83**) with bunch number (BNO) and both traits were positively correlated (r = 0.50** and r = 0.42**) with OY. Therefore, OY can be improved by increasing BN or FFB yield. Palms from populations SEN 02 and SEN 05 performed the best among all populations and these palms can be selected for progeny testing for drought tolerance as these palms were sampled in low rainfall and high temperature part of Senegal.

ABSTRAK

VARIASI GENETIK DAN PRESTASI POPULASI SAWIT (*Elaeis guineensis* Jacq.) DARI SENEGAL

Kajian genetik telah dijalankan pada germplasma sawit yang berasal dari Senegal yang telah dikumpulkan oleh pihak Lembaga Minyak Sawit Malaysia (MPOB) yang dahulunya dikenali sebagai PORIM pada tahun 1993. Sebanyak lima sampel dari setiap kelompok keluarga dari 13 kawasan (populasi) diperolehi secara rawak untuk mengumpul maklumat tentang perbezaan di peringkat populasi, famili dan anak pokok. Germplasma dari Senegal ini ditanam di MPOB Kluang, Johor pada Jun 1996. Sejumlah 415 pokok telah ditanam di plot 0.352 di dalam dua replikasi mengikut reka bentuk blok rawak bebas (ICRD). Ciri-ciri yang dikaji adalah hasil tandan, kualiti tandan, pertumbuhan vegetatif dan ciri fisiologi. Objektif kajian ini adalah untuk menilai prestasi dan struktur genetik populasi, menentukan kepelbagaian pewarisan genetik di antara progeni, menentukan heritabiliti dan mengkaji korelasi fenotip antara semua ciri-ciri yang dikaji. Oleh kerana terdapat data yang hilang disebabkan pokok yang mati, hanya 358 anak pokok telah dikaji. Sejumlah 35 ciri telah dinilai dalam kajian ini. Ujian analisis varians (ANOVA) bagi sembilan populasi menunjukkan variasi yang signifikan oleh kebanyakan ciri-ciri yang dikaji kecuali nisbah isirong ke buah (K/F), nisbah isirong ke tandan (K/B) dan nisbah luas daun (LAR). ANOVA bagi 14 progeni pula menunjukkan variasi yang signifikan ($P \leq 0.01$) oleh kebanyakkan ciri-ciri yang dikaji. Anggaran heritabiliti bagi hasil tandan dan komponennya adalah h^2_B = 40-60%. Bagi ciri-ciri kualiti tandan pula, anggaran heritabiliti adalah rendah dengan julat di antara (h^2_B < 50%), dimana nilai paling rendah (h^2_B = 10%) diperolehi dari purata kandungan mesokarpa (M/F) dan nilai paling tinggi (h^2_B = 46%) diperolehi dari hasil minyak (OY). Bagi ciri-ciri pertumbuhan vegetatif, anggaran heritabiliti adalah h^2_B < 65% kecuali bilangan pelepah yang dihasilkan (FP) dengan nilai heritabiliti yang paling rendah h^2_B = 12%. Ciri-ciri fisiologi pula memperolehi nilai heritabiliti yang tinggi iaitu antara 40 - 60%. Hasil berat tandan segar (FFB) menunjukkan korelasi positif, ($r = 0.83^{**}$) di antara bilangan tandan (BNO) dan kedua-dua ciri ini menunjukkan korelasi positif ($r = 0.50^{**}$ and $r = 0.42^{**}$) dengan OY. Pokok-pokok dari populasi SEN 02 dan SEN 05 menunjukkan prestasi yang terbaik di antara kesemua populasi dan boleh dipilih untuk ujikaji progeni bagi toleransi terhadap kemarau kerana sampel-sampel ini di ambil dari kawasan taburan hujan yang rendah dan suhu yang tinggi di Senegal.

الملخــص

الاختلاف الجيني وأداء تجمعات النخيل من طراز (*إيلايس جينينسيس جاق.*) من السنغال

وقد أجريت الدراسات الوراثية على المادة الوراثية لنخيل من السنغال التي تم جمعها من قبل مجلس زيت النخيل الماليزي (MPOB)، المعروف سابقا باسم PORIM في عام 1993. وتم جمع معلومات حول الاختلافات في مستوى التجمعات والجنس وفسائل النخيل عشوائيا من خمس عينات من كل مجموعة عائلة من 13 منطقة. زرعت هذه المادة الوراثية من السنغال في MPOB في كلوانغ، جوهور في يونيو عام 1996. وقد زرعت 415 شجرة في قطاع 0.352 في النسختين المتماثلتين وفق تصميم كامل العشوائية المستقلة (Independent Completely Randomized Design). والأمور المدروسة هنا هي صفات باقة، وجودتها، والنمو الخضري والخصائص الفسيولوجية. تهدف هذه الدراسة إلى تقييم الأداء والتركيب الوراثي لتجمعات النخيل، وتحديد تنوع الوراثة الجينية بين السلالات، وتحديد إمكانية التوريث والبحث في ارتباطات النمط الظاهري بين جميع الصفات المدروسة . وقد درست 358 شتلة النخيل فقط لفقدان البيانات بسبب ماتت شجرة. وتم تقييم 35 صفات من خلال هذه الدراسة. وأظهر تحليل اختبار التباين (ANOVA) من تسعة تجمعات الشتلة تفاوتا واضحا لمعظم الصفات المدروسة باستثناء نواة لفاكهة (K / F) ، ونواة لمجموعة (K / B) ونسبة مساحة الورقة (LAR) . أظهرت كذلك ANOVA لمدة 14 السلالة فرقا كبيرا ($P \leq 0.01$) لمعظم الصفات المدروسة. إمكانية التوريث المقدرة لعائدات باقة ومكوناتها هي h^2_B ـ 40-60%. أما بالنسبة لصفات جودة باقة، إمكانية التوريث المقدرة أصبحت منخفضة تتراوح ما بين ($h^2_B <50$٪)، حيث أقل قيمة10 = h^2_B) ٪ (تم الحصول عليها من متوسط المحتوى من الثمرة (M/F) ، وأما أعلاها = h^2_B) 46٪ (المستمدة من عائدات النفط (OY). ولخصائص النمو الخضري، إمكانية التوريث المقدرة هي $h^2_B < 65\%$ باستثناء إنتاج السعفة (FP) مع أدنى قيمة إمكانية التوريث $h^2_B = 12\%$. كانت الصفات الفسيولوجية تم الحصول على أعلى قيمة إمكانية التوريث من بين 60% - 40. أظهرت نتائج الباقات الثقيلة الطازجة (FFB) ارتباطات إيجابية، ($r = 0.83^{**}$) وبين عدد عناقيد (BNO) وكلي من هاتين الصفتين تدلان على ارتباطات إيجابية ($r = 0.50^{**}$ and $r = 0.42^{**}$) مع OY . وبالتالي، فإنه يمكن تحسينها من خلال زيادة BN أو العائد FFB.

كل شجرة من SEN 02 وSEN 05 تدل على أفضل أداء بين جميع تجمعات النخيل، ويمكن اختيارها لتجربة إمكانيتها في تحمل الجفاف لأن هذه العينات مأخوذة من مناطق التي قلائل الأمطار ومرتفات درجات الحرارة في السنغال.

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ABBREVIATIONS

ABW	Average Bunch Weight
AVROS	Algemene Vereniging van Rubberplanters ten Oostkust van Sumatra
BDM	Bunch Dry Matter
BI	Bunch Index
BNO	Bunch Number
BPRO	Breeding Populations of Restricted Origin
BWT	Bunch Weight
CAPS	Cleaved Amplified Polymorphic Site
CRD	Completely Randomized Design
CV	Coefficient of Variation
DIA	Diameter of Trunk
DNMRT	Duncan New Multiple Range Test
DOA	Department of Agriculture
D×P	*dura* × *pisifera*
e	Light Conversion Efficiency
f	Fractional Interception of Light
F/B	Fruit to Bunch
FFB	Fresh Fruit Bunch
FP	Frond Production
GxE	Genotype x Environment
GCA	General Combining Ability
GHG	Greenhouse Gas
h^2_B	Broad-sense Heritability
HT	Trunk Height

ICRD	Independent Completely Randomized Design
IRHO	Institute pour Recherche sur les Huiles at Oleaginuex
K/B	Kernel to Bunch
K/F	Kernel to Fruit
kg/p/yr	Kilogram Per Palm Per Year
KY	Kernel Yield
LA	Leaf Area
LAI	Leaf Area Index
LAR	Leaf Area Ratio
LL	Leaflet Length
LN	Leaflet Number
LW	Leaflet Width
M/F	Mesocarp to Fruit
MARDI	Malaysian Agricultural Research and Development Institute
MFW	Mean Fruit Weight
MNW	Mean Nut Weight
MC	Moisture Contents
MPOB	Malaysian Palm Oil Board
MRS	Modified Recurrent Selection
MS	Mean Square
NAR	Net Assimilation Rate
NCM 1	North Carolina Model 1
NIFOR	Nigerian Institute for Oil Palm Research
ns	Not Significant
no./p/yr	Number Per Palm Per Year
O/B	Oil to Bunch
O/DM	Oil to Dry Mesocarp

O/WM	Oil to Wet Mesocarp
OPGL	Oil Palm Genetic Laboratory
OPM	Oil Palm of Malaya
OY	Oil Yield
PCS	Petiole Cross-Section
PORIM	Palm Oil Research Institute of Malaysia
r	Correlation Coefficient
RCBD	Randomized Complete Block Design
RRS	Reciprocal Recurrent Selection
RL	Rachis Length
S/F	Shell to Fruit
SA	Serdang Avenue *dura*
SSR	Simple Sequence Repeat
TAG	Triacylglycerols
VIR	Virescens