



**Ministry of Agriculture, Livestock and Irrigation
Department of Agriculture
Perennial Crops Division**



Perennial Crops Research and Development Center(Mawlamyine)

**Genetic Variation for Vegetative Traits in Dura x Dura mother
palm families originating from Cost Rica**

**Presented By
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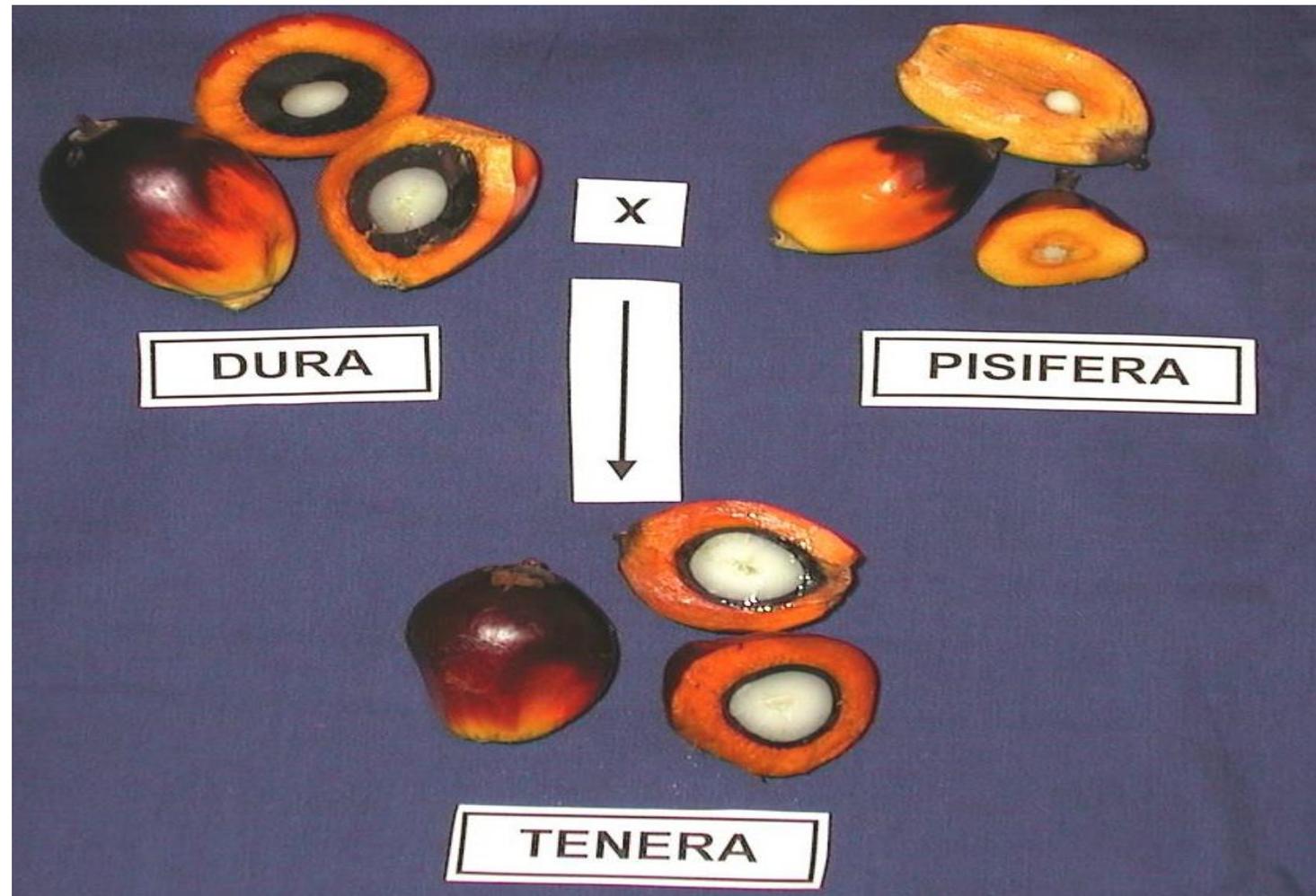
Presentation outlines

- Introduction
- Problem Statement
- Objectives
- Materials and Method
- Results and Discussions
- Conclusion
- References

Introduction

- Oil palm planting materials in ASEAN countries are mainly derived from four Bogor palms.
- *Elaeis guinesis* was introduced to Myanmar in the 1920s
- At that time, only Dura varieties imported from Malaysia were used for oil palm cultivation.
- Tenera hybrids (Dura x Pisifera) with higher yield (1960)
- widespread cultivation was delayed due to high prices of germinated seeds from Malaysia, Costa Rica and Nigeria.

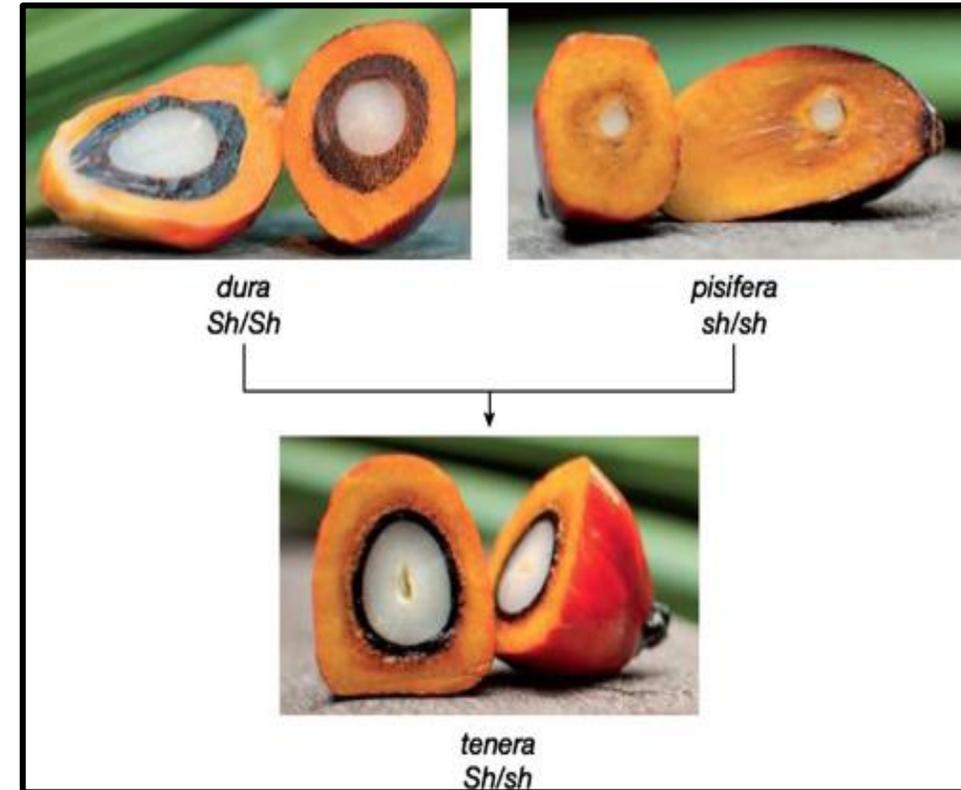
D × P Cross



Introduction

Characteristics of dura, tenera and pisifera fruit forms

Fruit form Characteristic	Dura	Tenera	Pisifera*
Shell thickness (mm)	2–8	0.5–4	Shell-less
Fibre Ring	Absent	Present	Absent
Mesocarp to fruit ratio (%)	35–55	60–96	95
Kernel to fruit ratio (%)	7–20	3–15	
Oil to Bunch (%)	16	26	



* female sterile where bunches seldom develop to maturity.
Source: Hardon et al. 1985; Hartley 1988.

Introduction (Cont.)

- Eight Tenera hybrids of Costa Rica (ASD) were purchased and cultivated at Perennial Plant Research Research (Mawlamyine)
 1. Deli × Lame
 2. Deli × Ghana
 3. Deli × AVROS
 4. Deli × Ekona
 5. Tanazania × AVROS
 6. Tanazania × Ekona
 7. Barmenda × Ekona
 8. Barmenda × AVROS

Introduction (Cont.)

- These hybrids were selected and self-fertilized in 2000 under the TCP / MYA / 3101 Improving Oil Palm research, development and production project under the training and guidance of foreign oil palm technicians at the Research Center for Perennial Plants (Mawlamyine)
 1. Deli × AVROS (Selfing)
 2. Deli × Ekona (Selfing)
 3. Deli × Lame (Selfing)
 4. Tanazania × AVROS (Selfing)
 5. Tanazania × Ekona (Selfing)
- In 2010, Seed garden (Dura mother palm and Pisifera father palm) was established in Perennial Plant Research and Technology Development Center (Hasdin), Kawthoung.

Introduction (Cont.)

- The government planned to expand oil palm cultivation to 500,000 acres in Tanintharyi Region
- In 1998, the government planned to expand the cultivation of palm oil in 500,000 acres in Tanintharyi Region, and now 401981 acres have been planted (2019) with 149284 acres as harvested area
- Some of the current oil palm plantations were will have to be felled and replanted by 2025

Problem Statements

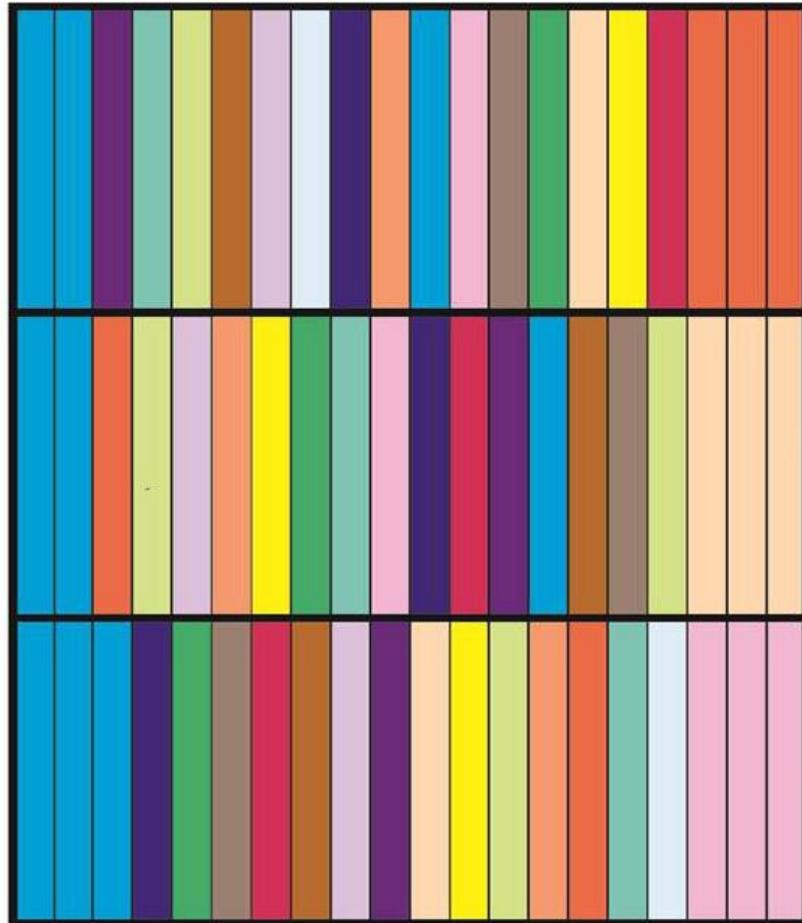
- High-yielding hybrid which are adaptable to Tanintharyi division are required.
- Breeders are now emphasizing not only on oil yield but also for better adaptation to drought, heat and other abiotic stress, and dwarf palm for easy harvesting to meet future demands
- Genetic variation of parentage are need to be identified for further breeding program.

Objectives

- To quantify genetic diversity on vegetative traits of Dura mother palms
- To estimate heritability values
- To select superior families for further improvement and development of D×P planting materials for commercial cultivation.

Material and Method

Genetic Cross မိခင်မျိုးလိုင်း: Dura x Dura Progeny Trial စမ်းသပ်ကွက်



RIII

RII

RI

စိုက်ပျိုးသည့်ခုနှစ်

- ၂၀၁၀ - ၂၀၁၁ ခုနှစ်

စိုက်စနစ်အကွာအဝေး

- ၃၀' Δ

စမ်းသပ်ကွက်ဧရိယာ

- ၁၄ ဧက

အပင်အရေအတွက်

- ၇၄၉ ပင်

စမ်းသပ်ကွက်ပုံစံ

- RCB Design

ပြုမူဆောင်ရွက်ချက် (Treatment)

- ၁၆

ထပ်ကြိမ် (Replication)

- ၃

Genetic Cross မိခင်စစ်မျိုးများ

DE 6/11 D x DL 2/10 D

DA 3/15 D x DL1/6D

DL 3/6 D x DE 6/11 D

DL 3/3 D x DE6/11D

DL 1/2 D x DE 5/10 D

DL 2/6 D x DA3/11D

DL 1/3 D x DE 5/10 D

DA 4/2 D x DL2/5D

DL 2/5 D x DL 2/5 D

DA 3/15 D x DA3/15D

DA 4/2 D x DE 6/11 D

DE 7/6 D x DA3/11D

DL 2/5 D x DE 5/5 D

DL 3/3 D x DA3/11D

DL 2/10 D x DA 3/11 D

DL 2/11 D x DE6/4D

Data Collection

- Yield recording
- Bunch analysis
- Vegetative measurement

Data Collection

Petiole width



Petiole depth

Leaflet width



Leaflet length



Rachis Length



Trunk Height



Trunk Diameter

Vegetative measurement

Characters	Calculation
Petiole Cross Sectional Area (PCS,cm ²)	Petiole depth x petiole width
Rachis Length (RL, cm)	Length from tip of rachis to the first of ligule
Leaf length (LL, cm)	$(LL1+LL2+LL3+LL4+LL5+LL6)/6$
Leaflet width (LW, cm)	$[LW1+LW2+LW3+LW4+LW5+LW6/6]$
Leaflet number (LN, no/p/yr)	(number of fronds on one side of rachis) × 2
Trunk Diameter (DIA, cm)	Diameter of trunk at one meter from ground
Trunk Height (HT, m)	Height of trunk of ground to base of frond 41
High increments (HTI, cm/yr)	(HT at year t)/ (age at year t – 2)
Leaf Area (LA, m ²)	$((L1 \times W1)+(L2 \times W2)+(L3 \times W3)+(L4 \times W4) + (L5 \times W5)+(L6 \times W6) \times LN \times 2 \times 0.57)/6/10000$

Source Blaak et al.,1963; Roa et al., 1983; Kushairi (1998)

Data Analysis

- Simple statistics such as progenies mean, standard error, standard deviation using SAS 9.4 software
- Simple statistics such as progenies mean, standard error, standard deviation
- ANOVA
- Means comparison (Tukey's HSD)
- Genetic variances and heritability values
- Cluster and Principal component analysis using NTSYS-PC software

Data analysis

- **Genotypic variance:** $\sigma_g^2 = \frac{(MSG - MSE)}{r}$

Where MSG is the mean square of genotypes, MSE is the mean square of error, r is the number of replications.

- **Phenotypic variance:** $\sigma_p^2 = \sigma_g^2 + \sigma_e^2$

Where, σ_g^2 is the genotypic variance, and σ_e^2 is the mean squares of error.

- **Error variance:** $\sigma_e^2 = MSE$

Where MSE is the mean square of error.

Data analysis

- Phenotypic Coefficient of Variance (PCV,%)

$$PCV = \frac{\sqrt{\sigma_p^2}}{\bar{X}} \times 100$$

- Genotypic Coefficient of Variance (GCV, %)

$$GCV = \frac{\sqrt{\sigma_g^2}}{\bar{X}} \times 100$$

Where σ_p^2 is the phenotypic variance, σ_g^2 is the genotypic variance and \bar{X} is the mean of the trait. PCV and GCV percentage were categorized as

- Low - (0-10%)
- Moderate - (10-20%)
- High – (>20%)

Sivasubramanian and Madhava (1973).

Data analysis

Heritability

- The heritability h^2 (broad sense) is the ratio of genetic variance (σ_g^2) to phenotypic variance (σ_p^2)

$$h^2(\%) = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

Where σ_g^2 is the genotypic variance and σ_p^2 is the phenotypic variance. Heritability percentage will be categorized as

Low: 0-30%

Moderate: 30-60%

High: > 60%

(Robinson *et al.*, 1949)

Result and Discussion

Source of variation	df	PCS	RL	LN	LW	LL
Replication(R)	2	220.93**	0.23 ^{ns}	322.71 ^{ns}	1.60*	40.50 ^{ns}
Family(F)	15	120.51**	0.99**	1216.06**	4.24**	258.11**
Error	30	35.99	0.40	225.69	0.51	92.30
σ^2_f		6.02 (14.30)	0.04 (9.50)	71.07 (23.94)	0.26 (33.68)	11.55 (11.18)
σ^2_e		36.05 (85.70)	0.39 (90.50)	225.86 (76.06)	0.51 (66.32)	91.75 (88.82)
CV		24.80	13.15	11.86	18.99	11.04
Mean		26.42	5.00	143.84	4.60	91.83

- significant variability among the families based vegetative traits except palm diameter (DIAM)

Result and Discussion

Source of variation	df	LA	HT	HI	DIAM
Replication(R)	2	6.35 ^{ns}	2.44**	381.17**	1.69 ^{ns}
Family(F)	15	14.63**	2.71**	423.07**	1.79 ^{ns}
Error	30	2.31	0.28	44.11	2.18
σ^2_f		0.85 (26.88)	0.18 (39.01)	28.23 (39.01)	0
σ^2_e		2.31 (73.12)	0.28 (60.99)	44.14 (60.99)	2.15 (100)
CV		25.52	20.00	20.00	52.81
Mean		6.95	3.39	42.32	2.78

- significant variability among the families based vegetative traits except palm diameter (DIAM)

Family means for vegetative traits

No	Family	N	PCS	RL	LL	LW	LN
1	DA3/15D X DA3/15D	7	19.06 ^b	4.72 ^b	94.74 ^{ab}	3.46 ^f	126.42 ^f
2	DA4/2DDE6/11D	6	25.31 ^{ab}	4.77 ^{ab}	92.02 ^{ab}	4.05 ^{def}	132.40 ^{def}
3	DA4/2DDL2/5D	6	24.64 ^{ab}	4.73 ^b	96.57 ^{ab}	3.92 ^{ef}	137.00 ^{cdef}
4	DL2/6DDA3/11D	20	27.65 ^a	5.36 ^{ab}	95.20 ^{ab}	4.53 ^{bcde}	158.33 ^{ab}
5	DE7/6DDA3/11D	19	25.40 ^{ab}	5.12 ^{ab}	86.19 ^b	4.70 ^{abcde}	144.66 ^{abcdef}
6	DE6/11DDL2/10D	7	28.70 ^a	5.02 ^{ab}	93.49 ^{ab}	4.24 ^{cdef}	141.133 ^{abcdef}
7	DL3/3DDA3/11D	19	25.77 ^{ab}	5.10 ^{ab}	94.32 ^{ab}	5.35 ^{ab}	142.80 ^{abcdef}
8	DL3/3DDE6/11D	13	25.06 ^{ab}	4.78 ^{ab}	84.57 ^b	4.64 ^{abcde}	152.40 ^{abc}
9	DL2/10DDA3/11D	12	26.01 ^{ab}	4.77 ^{ab}	94.21 ^{ab}	4.43 ^{bcde}	142.20 ^{abcdef}
10	DL2/11DDE6/4D	20	29.28 ^a	5.27 ^{ab}	99.07 ^a	4.22 ^{cdef}	147.13 ^{abcde}
11	DL3/3DDE6/11D	5	27.73 ^a	4.95 ^{ab}	90.06 ^{ab}	5.51 ^a	150.13 ^{abcd}
12	DL2/5DDE5/5D	18	29.07 ^a	5.55 ^a	93.92 ^{ab}	4.93 ^{abcd}	160.57 ^a
13	DL1/3DDE5/10D	6	30.56 ^a	5.28 ^{ab}	86.93 ^{ab}	5.15 ^{abc}	148.00 ^{abcde}
14	DL1/2DDE5/10D	9	29.69 ^a	4.99 ^{ab}	85.94 ^b	4.89 ^{abcd}	140.92 ^{bcdef}
15	DL3/6DDE6/11D	18	24.94 ^{ab}	4.83 ^{ab}	89.72 ^{ab}	4.71 ^{abcde}	141.73 ^{ab}
16	DL2/5DDL2/5D	7	22.83 ^{ab}	4.67 ^b	91.26 ^{ab}	4.98 ^{abcd}	129.88 ^{ef}
Mean			26.42	5.00	91.83	4.60	143.84
Std.dev			6.55	0.66	10.14	0.87	17.07
HSD			7.84	0.82	12.55	0.93	19.63

- The smaller PCS and shorter RL were recorded in DA3/15D X DA3/15D
- lower than D×P standard cross of PCS (39.3 cm²) and RL (6.1 m) (Samsul et al., 2018).

Family means for vegetative traits in Senegal trial

No	Family	N	LA	HT	HI	DIAM
1	DA3/15D X DA3/15D	14	4.75 ^e	2.36 ^d	29.60 ^d	4.01 ^a
2	DA4/2DDE6/11D	15	5.70 ^{de}	3.70 ^b	46.28 ^{ab}	2.59 ^a
3	DA4/2DDL2/5D	15	6.04 ^{cde}	3.30 ^{bc}	41.28 ^{bc}	2.58 ^a
4	DL2/6DDA3/11D	15	7.80 ^{abc}	3.21 ^{bc}	40.23 ^{bc}	2.71 ^a
5	DE7/6DDA3/11D	15	6.69 ^{abcde}	3.09 ^{bc}	38.70 ^{bc}	2.63 ^a
6	DE6/11DDL2/10D	15	6.42 ^{bcde}	3.58 ^b	44.78 ^b	2.77 ^a
7	DL3/3DDA3/11D	15	8.15 ^{ab}	3.41 ^{bc}	42.62 ^{bc}	2.89 ^a
8	DL3/3DDE6/11D	15	6.86 ^{abcd}	3.34 ^{bc}	41.75 ^{bc}	2.50 ^a
9	DL2/10DDA3/11D	15	6.77 ^{abcd}	3.48 ^{bc}	43.54 ^{bc}	2.65 ^a
10	DL2/11DDE6/4D	15	7.02 ^{abcd}	3.72 ^b	46.56 ^b	2.67 ^a
11	DL3/3DDE6/11D	15	8.47 ^a	3.43 ^{bc}	42.95 ^{bc}	2.82 ^a
12	DL2/5DDE5/5D	14	8.53 ^a	3.08 ^{bc}	38.52 ^{bc}	2.59 ^a
13	DL1/3DDE5/10D	14	7.52 ^{abcd}	3.33 ^{bc}	41.66 ^{bc}	2.81 ^a
14	DL1/2DDE5/10D	13	6.71 ^{abcde}	4.46 ^a	55.76 ^a	2.92 ^a
15	DL3/6DDE6/11D	15	6.92 ^{abcd}	3.61 ^b	45.18 ^b	2.83 ^a
16	DL2/5DDL2/5D	9	6.78 ^{abcd}	2.85 ^{cd}	35.56 ^{cd}	2.38 ^a
Mean			6.95	3.39	42.31	2.77
Std.dev			1.77	0.68	8.46	1.47
HSD			1.99	0.69	8.68	1.93

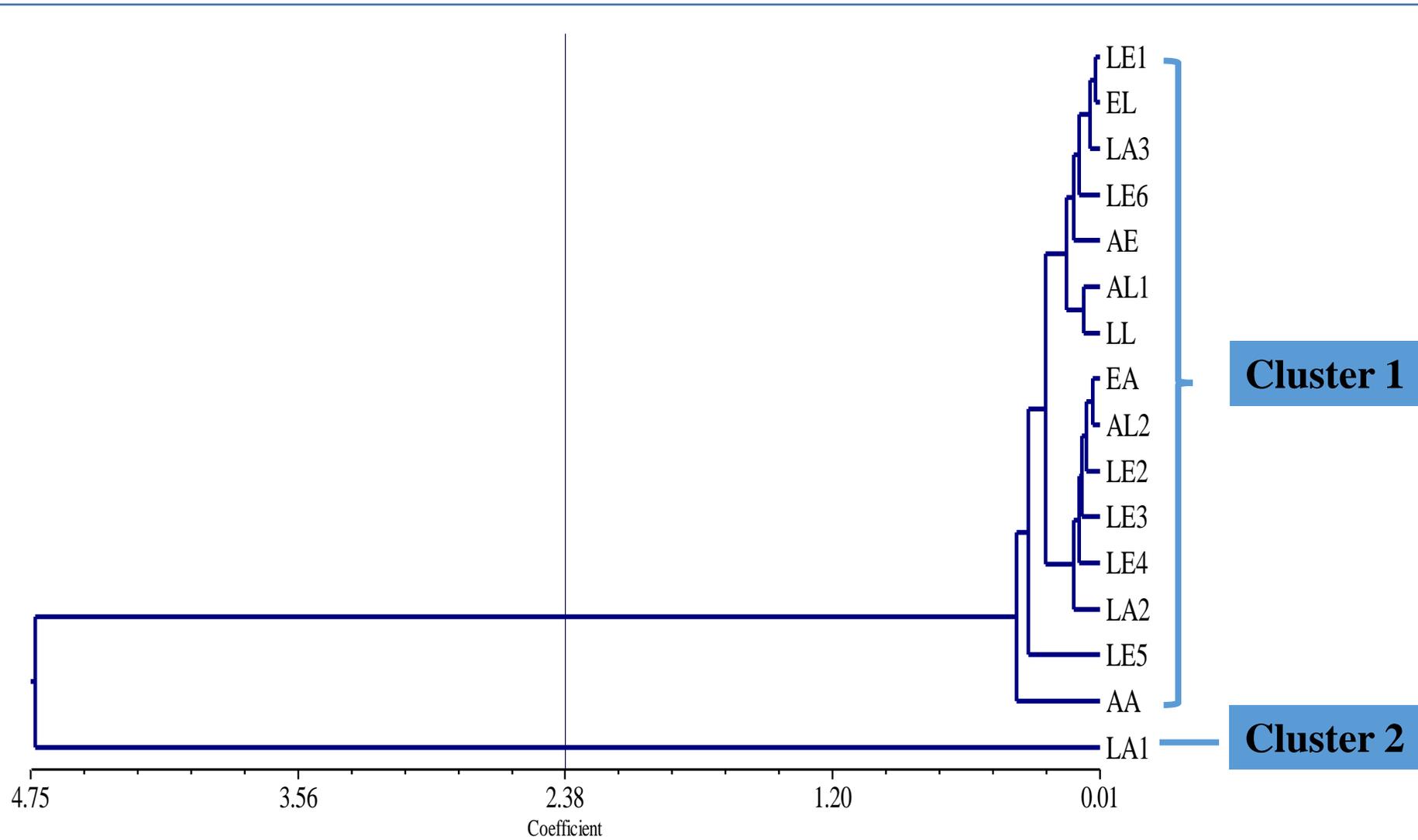
• The slowest height increment was observed in DA3/15D X DA3/15D which is lower than those of current oil palm planting material (40-75cm/yr)

Heritability, phenotypic and genotypic coefficient of variances of vegetative traits

Trait	H^2_f (%)	PCV _f (%)	GCV _f (%)
PCS	28.60	24.55	9.28
RL	19.00	13.20	4.07
LN	47.87	11.98	5.86
LW	67.36	19.11	11.09
LL	22.36	11.07	3.70
LA	53.77	25.60	13.27
HT	78.01	20.08	12.54
HI	78.01	20.11	12.56
DIAM	0	52.76	0

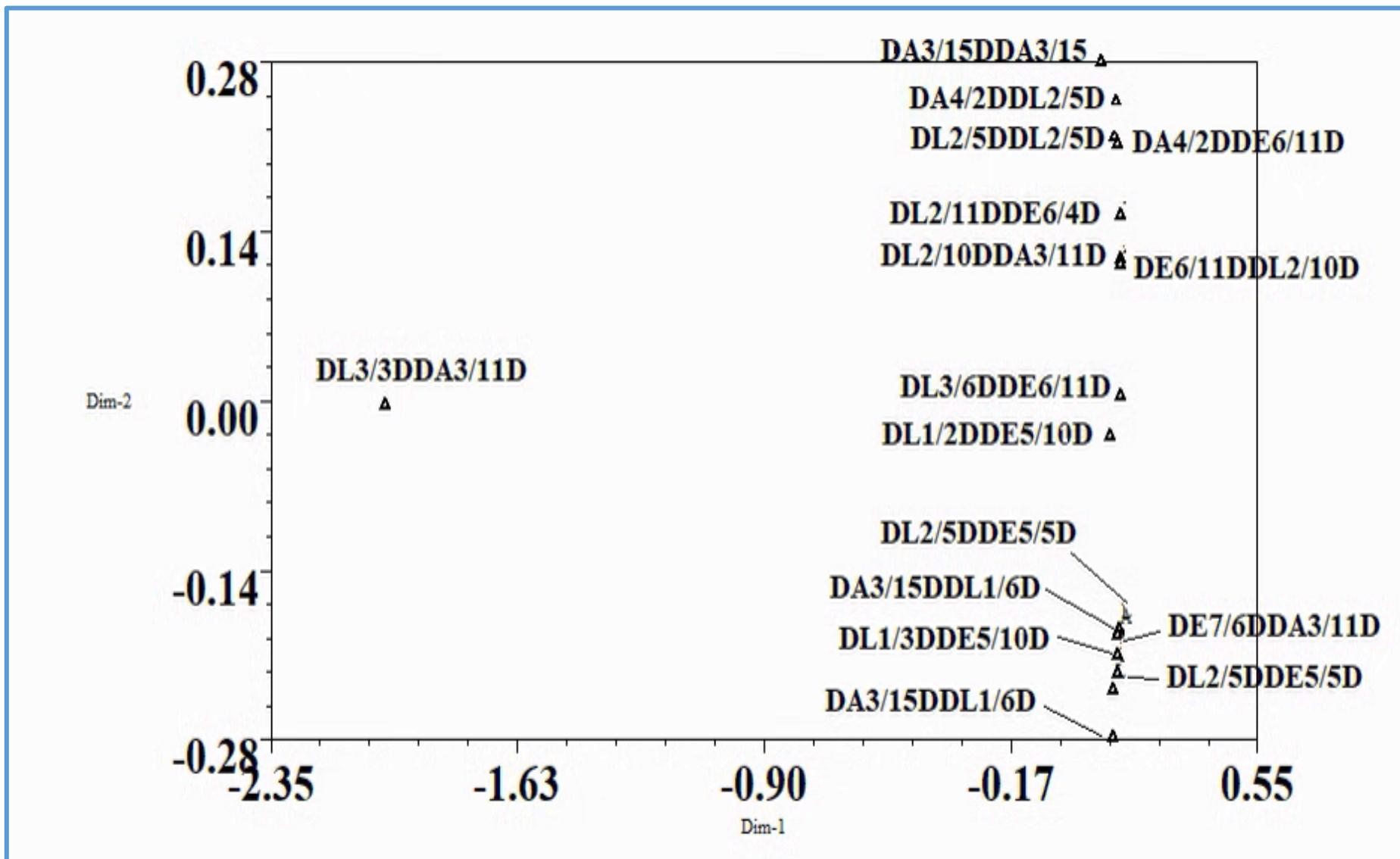
- Leave width, plant height and height increment had high broad-sense heritability value
- PCV were ranged from moderate to high where as GCV were low to moderate

Cluster Analysis



• Two distinct clusters at the similarity coefficient of 2.38.

Principal Component Analysis



Conclusion

- Exhibited genetic variation of vegetative traits among the Dura x Dura mother palm.
- Family DA3/15D X DA3/15D was identified as potential family for dwarf trait.
- The highest genetic distance was observed from family DL3/3DDA3/11D to the rest families and could be used for hybridization

References

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Thank you for your kind attention.