# EVALUATION OF BUNCH INDEX IN THE MPOB GERMPLASM COLLECTIONS[1]

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## ABSTRACT

*Some 11 germplasms of oil palm (Elaeis guineensis Jacq.) namely, Nigeria, Cameroon, Zaire, Tanzania, Madagascar, Angola, Senegal, Gambia, Sierra Leone, Guinea and Ghana which involved 28 trials from the Malaysian Palm Oil Board (MPOB) collections, were evaluated for bunch index (BI), i.e. the proportion of bunch dry matter to total dry matter production. Besides Fresh Fruit Bunch yield, estimation of BI also requires the measurement of trunk height, trunk diameter, rate of frond production and petiole cross-section. BI values which derived by using the best four consecutive years of Fresh Fruit Bunch yield from each trial involved were collected and pooled according to their germplasms. Data analysis was by using analysis of variance (ANOVA), while the comparison between the germplasm means was by Fisher's Least Significant Difference (LSD) at the minimum 5% level of probability. The Tanzanian germplasm showed the highest mean of BI and significantly different than other germplasms for both duras (BI = 0.53) and teneras (BI = 0.54). Meanwhile, high variation of BI was noted among duras in the Madagascar germplasm (CV = 70.69%), while teneras of Guinea germplasm showed the highest variation for BI (CV = 42.01%). The broad-sense heritability of the BI for both duras and teneras were generally low. Senegal recorded the highest heritability of BI ($h^2_B$ = 94.41%) for duras while teneras from Ghana showed the highest heritability with 59.09%.*

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## INTRODUCTION

Malaysian Palm Oil Board (MPOB) has the largest collection of oil palm germplasm which have been field planted at MPOB Kluang Research Station. Collections of *E. guineensis* germplasms from 11 countries namely, Nigeria, Cameroon, Zaire, Tanzania, Madagascar, Angola, Senegal, Gambia, Sierra Leone, Guinea and Ghana have been carried out with numerous of plant explorations in Africa continent since 1973. The collection of germplasms from different genetic resources is essential to broaden the genetic base of current oil palm breeding material for multiple purposes. One of the purposes is to raise yield potential in oil palm.

Oil yield has been the major concern in oil palm cultivation. Hanif (2000) reported that one of the four possible ways to increase the oil production is by increasing the bunch index (BI) which derived from the ratio of bunch dry matter to total dry matter production (BDM / BDM + VDM). A total of six *dura* and six *tenera* palms with high BI were selected for PS7 – "Breeding Population with High BI" (Junaidah et. al 2004). The palms were selected from Tanzania and Nigeria materials with the bunch indexes ranged between 0.58 and 0.69. This paper evaluates BI of all the germplasms with hope that the study will be useful in future selection programmes in improving planting materials in Malaysia.

## MATERIALS AND METHODS

### Materials

The *duras* and *teneras* in this evaluation were from 28 trials planted in MPOB Kluang Research Station which involved 11 germplasms namely, Nigeria, Cameroon, Zaire, Tanzania, Madagascar, Angola, Senegal, Gambia, Sierra Leone, Guinea and Ghana. However, no *teneras* evaluated from Madagascar, Senegal and Gambia germplasm. The trials involved were planted between year 1975 and 2000, in various statistical design and replication as shown in *Table 1*.

### Methods

Bunch yield was started recorded at 36 months after field planting with two rounds per month by recording the bunch weight (BWT) and bunch number (BNO) on individual palm basis. Fresh Fruit Bunch (FFB) was the sum of the BWT. Meanwhile, one complete round of vegetative measurement using the non-destructive method (Corley and Breure, 1981) was taken after eight years after field planting.

BI is derived from the ratio of bunch dry matter to total dry matter production (BDM / ABDM + VDM), where the estimation requires the measurement of trunk height, trunk diameter, rate of frond production and petiole cross-section from the vegetative measurement, as well as FFB from the yield recording activity. Best four consecutive years of Fresh Fruit Bunch yield from each trial involved were used in calculating the BI.

**TABLE 1: INFORMATION ON GERMPLASM TRIALS EVALUATED FOR BUNCH INDEX**

| No. | Germplasm | Trial No. | Date Planted | Statistical Design | No. of Rep |
|---|---|---|---|---|---|
| 1. | Nigeria | 0.149 | Sept. 1975 | 8 cubic lactice | 3 |
| | | 0.150 | Apr. 1976 | 6 cubic lactice | 3 |
| | | 0.151 | May 1976 | CRD | 2 |
| | | 0.152 | May 1976 | CRD | 2 |
| 2. | Cameroon | 0.218 | Nov. 1986 | RCBD | 2 |
| | | 0.219 | Nov. 1986 | ICRD | 2 |
| 3. | Zaire | 0.220 | Nov. 1986 | ICRD | 2 |
| | | 0.221 | Nov. 1986 | ICRD | 2 |
| | | 0.222 | Dec. 1986 | ICRD | 2 |
| | | 0.223 | Dec. 1986 | ICRD | 2 |
| | | 0.224 | Dec. 1986 | RCBD | 2 |
| | | 0.225 | Dec. 1986 | RCBD | 2 |
| | | 0.226 | Jan. 1987 | RCBD | 3 |
| 4. | Tanzania | 0.256 | Aug. 1990 | RCBD | 4 |
| 5. | Madagascar | 0.240 | July 1990 | CRD | 1 |
| 6. | Angola | 0.311 | April 1994 | RCBD | 3 |
| | | 0.312 | April 1994 | CRD | 2 |
| | | 0.313 | April 1994 | Progeny Row | 1 |
| 7. | Senegal | 0.352 | June 1996 | ICRD | 2 |
| | | 0.396 | April 2000 | Progeny Row | 1 |
| 8. | Gambia | 0.357 | June 1996 | Progeny Row | 1 |
| | | 0.398 | May 2000 | Progeny Row | 1 |
| 9. | Sierra Leone | 0.355 | June 1996 | RCBD | 2 |
| | | 0.356 | June 1996 | ICRD | 1 |
| 10. | Guinea | 0.353 | June 1996 | RCBD | 2 |
| | | 0.354 | June 1996 | ICRD | 1 |
| | | 0.377 | Sept. 1997 | RCBD | 4 |
| 11. | Ghana | 0.397 | April 2000 | RCBD | 4 |

**Data Analyses**

BI values from each trial were pooled according to their germplasms and analysed by using analysis of variance (ANOVA), while the comparison between the germplasm means was by Fisher's Least Significant Difference (LSD) at the minimum 5% level of probability. Heritability of the trait was calculated using the intra-class coefficient.

## RESULTS AND DISCUSSIONS

***Duras*:** The Tanzania germplasm recorded the highest BI with a mean of 0.53 and range of 0.03 - 0.74 (*Table 2*). The high BI of the Tanzanian in comparison to the other germplasms is expected because six *duras* selected for PS7 came from this germplasm. Meanwhile, very low BI was recorded by the Madagascar germplasm with a mean of 0.08. Only 17 *dura* palms from Madagascar germplasm evaluated for BI, with majority of the palms showed low value

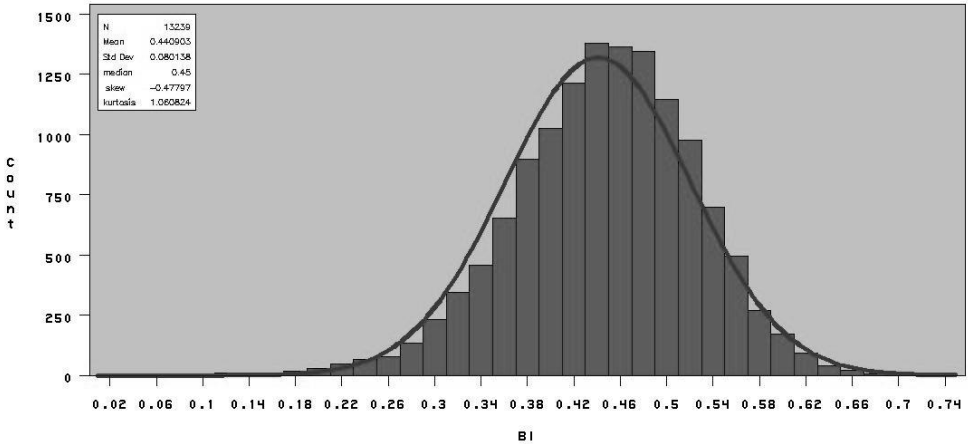
of BI due to the poor FFB yield. Surprisingly, Madagascar germplasm showed the highest variation as indicated by coefficient of variation (CV) value of 70.69%. The frequency distribution of BI among *duras* evaluated is shown in *Figure 1* and *2.* Majority of the germplasms had frequencies that approximated normal distribution with various mean values. However, the distribution of *duras* from Tanzania germplasms showed tendencies toward high BI.

**TABLE 2: PERFORMANCE OF BUNCH INDEX AMONG *DURAS* IN THE MPOB GERMPLASM COLLECTIONS**

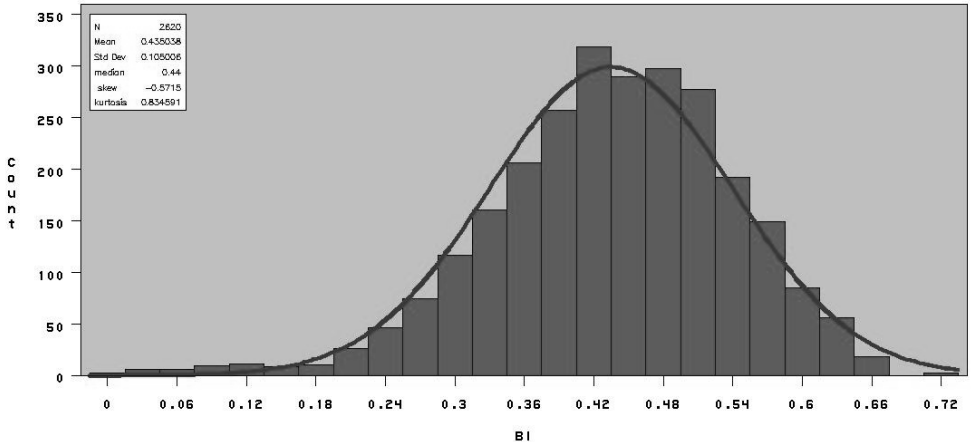
| No. | Germplasm | N | Mean | Minimum | Maximum | Coeff. of Variation (CV) |
|---|---|---|---|---|---|---|
| 1. | Nigeria | 13,239 | 0.44C | 0.01 | 0.74 | 18.18 |
| 2. | Cameroon | 2,620 | 0.44CD | 0.01 | 0.72 | 24.14 |
| 3. | Zaire | 7,715 | 0.40E | 0.01 | 0.74 | 25.42 |
| 4. | Tanzania | 2,051 | **0.53A** | 0.03 | 0.74 | 19.70 |
| 5. | Madagascar | 17 | **0.08H** | 0.01 | 0.22 | 70.69 |
| 6. | Angola | 1,942 | 0.48B | 0.08 | 0.70 | 15.86 |
| 7. | Senegal | 716 | 0.34FG | 0.01 | 0.61 | 36.90 |
| 8. | Gambia | 204 | 0.34G | 0.01 | 0.49 | 26.80 |
| 9. | Sierra Leone | 837 | 0.42D | 0.01 | 0.64 | 22.20 |
| 10. | Guinea | 1,059 | 0.42DE | 0.01 | 0.71 | 25.79 |
| 11. | Ghana | 2,466 | 0.36F | 0.01 | 0.61 | 30.60 |
| | Mean | 32,866 | 0.43 | 0.01 | 0.74 | 23.90 |
| | LSD | 0.02 | | | | |

Note: Means with the same letter are not significantly different at $p \leq 0.01$ based on LSD.

Figures in bold within mean column are the minimum and maximum values.




Nigeria

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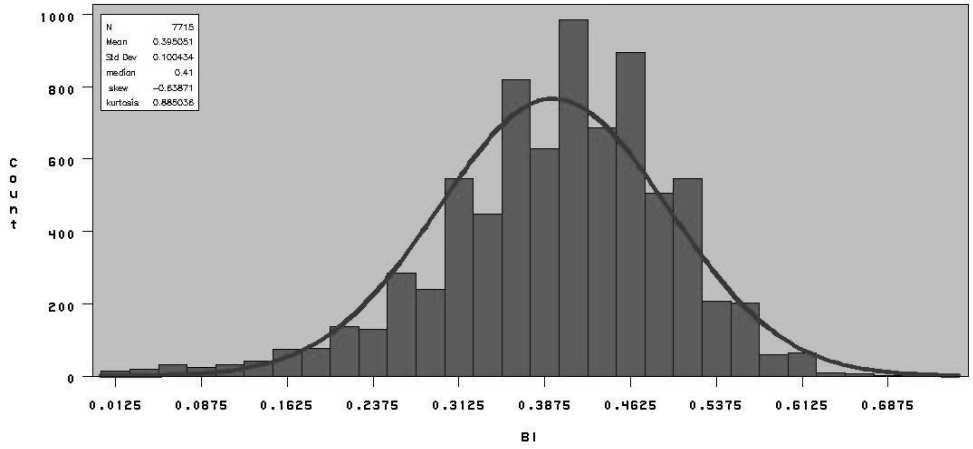


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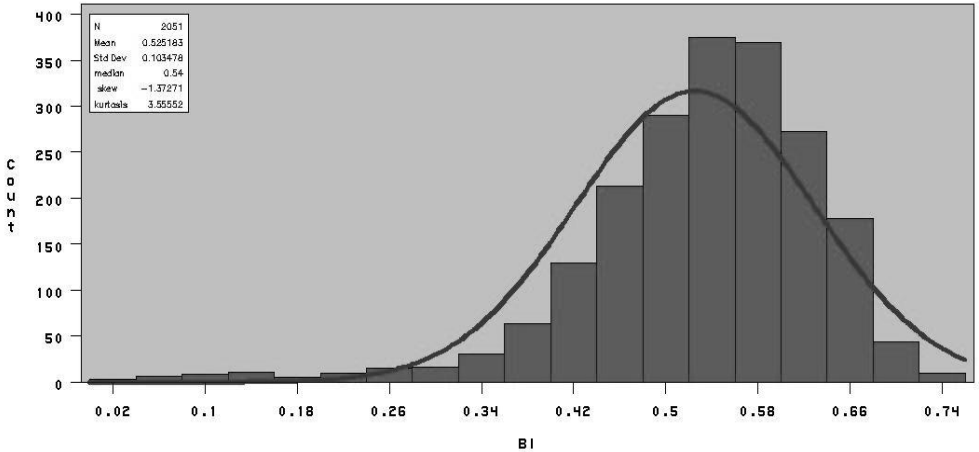
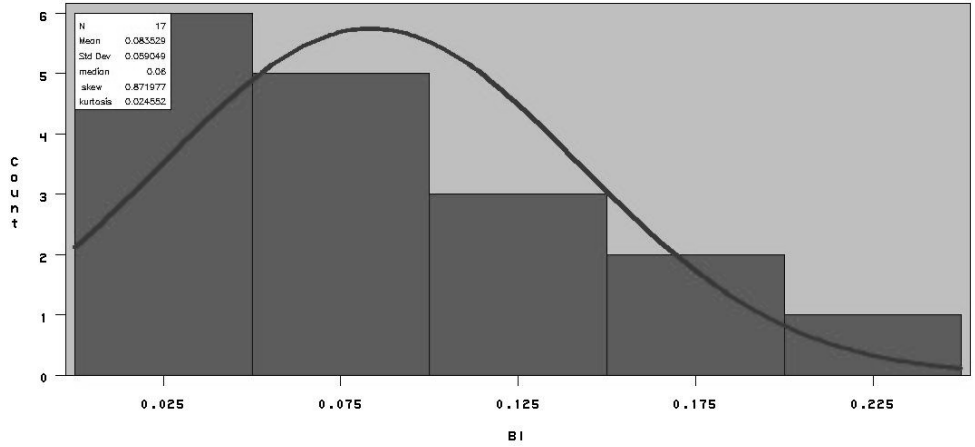
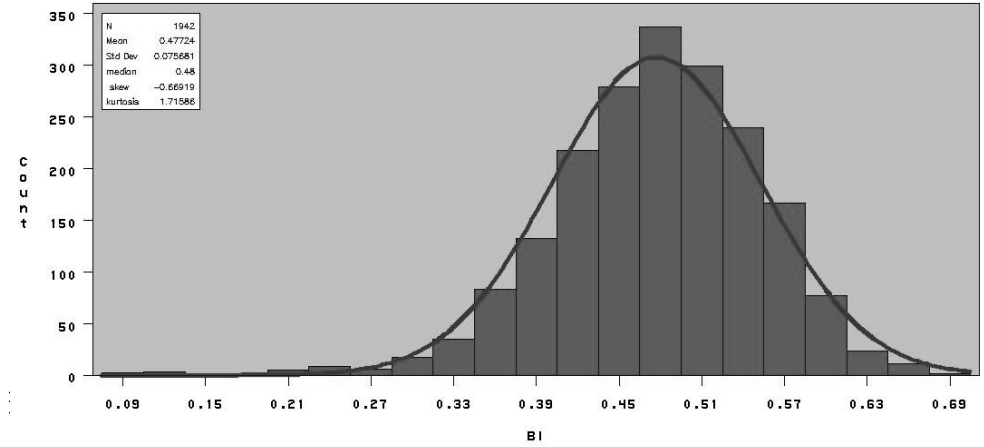



Tanzania

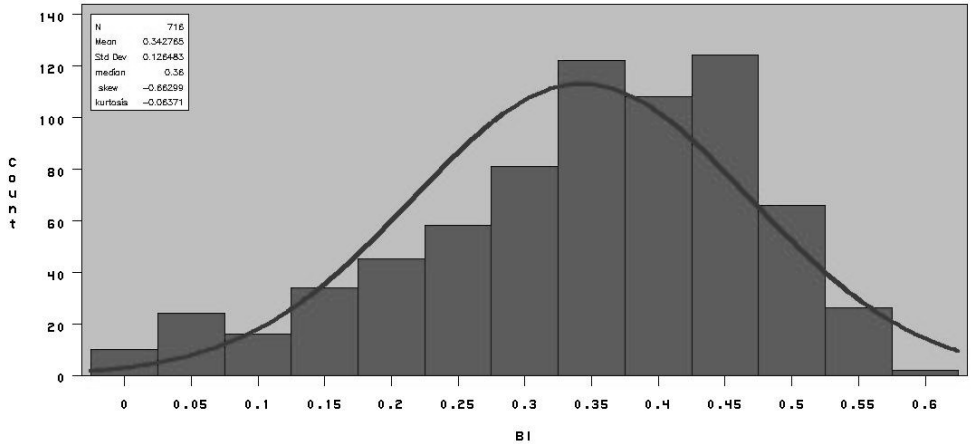



Madagascar

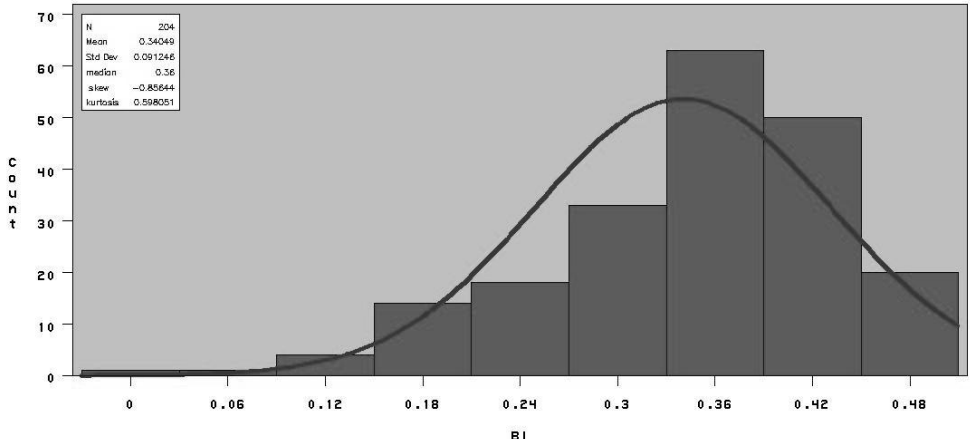



Angola

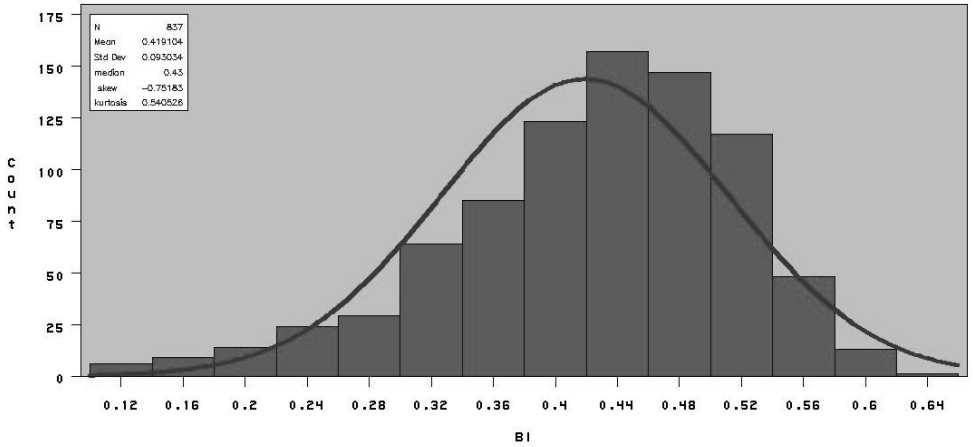
Figure 1: Frequency distribution of BI among *duras* in Nigeria, Cameroon, Zaire, Tanzania, Madagascar and Angola Germplasms



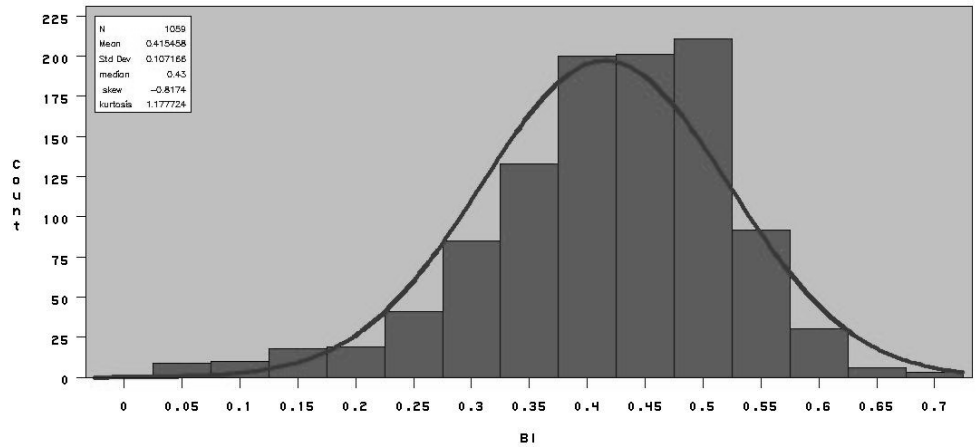

Senegal



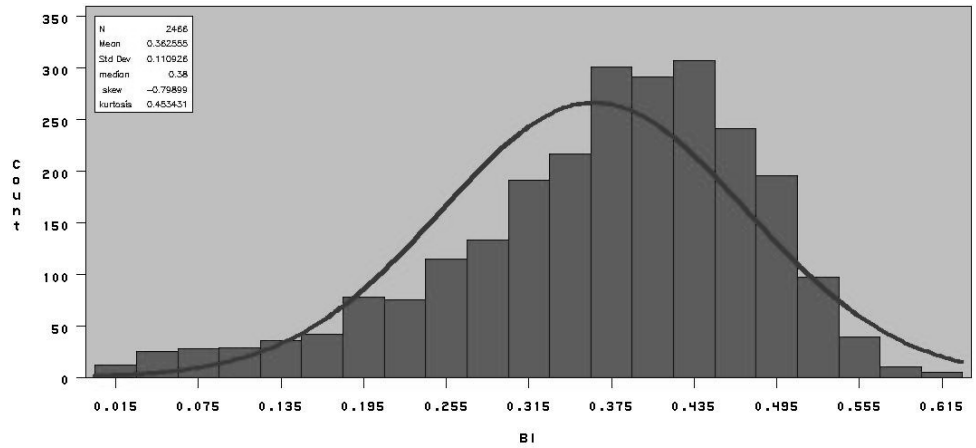

Gambia




Sierra Leone




Guinea




Ghana

Figure 2: Frequency distribution of BI among *duras* in Senegal, Gambia, Sierra Leone, Guinea and Ghana Germplasms

**TABLE 3: PERFORMANCE OF BUNCH INDEX AMONG *TENERAS* IN THE MPOB GERMPLASM COLLECTIONS**

| No. | Germplasm | N | Mean | Minimum | Maximum | Coeff. of Variation (CV) |
|---|---|---|---|---|---|---|
| 1. | Nigeria | 2,626 | 0.48B | 0.01 | 0.71 | 17.47 |
| 2. | Cameroon | 654 | 0.45C | 0.03 | 0.73 | 23.05 |
| 3. | Zaire | 1,243 | 0.41D | 0.02 | 0.74 | 24.56 |
| 4. | Tanzania | 565 | **0.54A** | 0.04 | 0.74 | 18.14 |
| 5. | Angola | 432 | 0.48B | 0.06 | 0.68 | 15.21 |
| 6. | Sierra Leone | 45 | 0.49B | 0.20 | 0.64 | 19.06 |
| 7. | Guinea | 73 | **0.37E** | 0.02 | 0.64 | 42.01 |
| 8. | Ghana | 143 | 0.38E | 0.04 | 0.57 | 30.02 |
| | Mean | 5,781 | 0.46 | 0.01 | 0.74 | 21.86 |
| | LSD | 0.02 | | | | |

Note: Means with the same letter are not significantly different at $p \leq 0.01$ based on LSD.
Figures in bold within mean column are the minimum and maximum values.

***Teneras*:** The Tanzania germplasm with range of BI between 0.04 and 0.74 also recorded the highest BI among *teneras* with a mean of 0.54 (*Table 3*). Meanwhile, Guinea germplasm showed the lowest BI with a mean of 0.37 and range of 0.02 - 0.64. The highest variation of BI can be detected in Guinea germplasm with CV value of 42.01%. *Figure 3* and *4* showed the frequency distribution of BI among *teneras* evaluated. The distribution of *teneras* with tendencies toward high BI is shown in Tanzania, Angola and Sierra Leone germplasms.

**Analysis of Variance** (ANOVA): *Table 4* and *5* presented mean squares and variance components for BI of the *duras* and teneras according to their germplasms, respectively. As for BI among *duras*, the ANOVA showed highly significant differences between families in all germplasms except Madagascar, which was non-significant. The heritability estimates for BI were generally low in all the germplasms. However, the Senegal germplasm recorded high heritability of BI ($h^2_B$ = 94.41%) which can be an advantage in future breeding programme. Corley et al. (1981) stated that it is important to consider BI and VDM production in breeding experiment as they are highly heritable characters.

Meanwhile, there were highly significant differences between families for BI among *teneras* in all germplasms except Angola and Guinea which were significant, and for Sierra Leone which was non-significant. The heritability estimates for BI were generally low in all the germplasms with Ghana germplasm recorded the highest heritability of 59.09%.

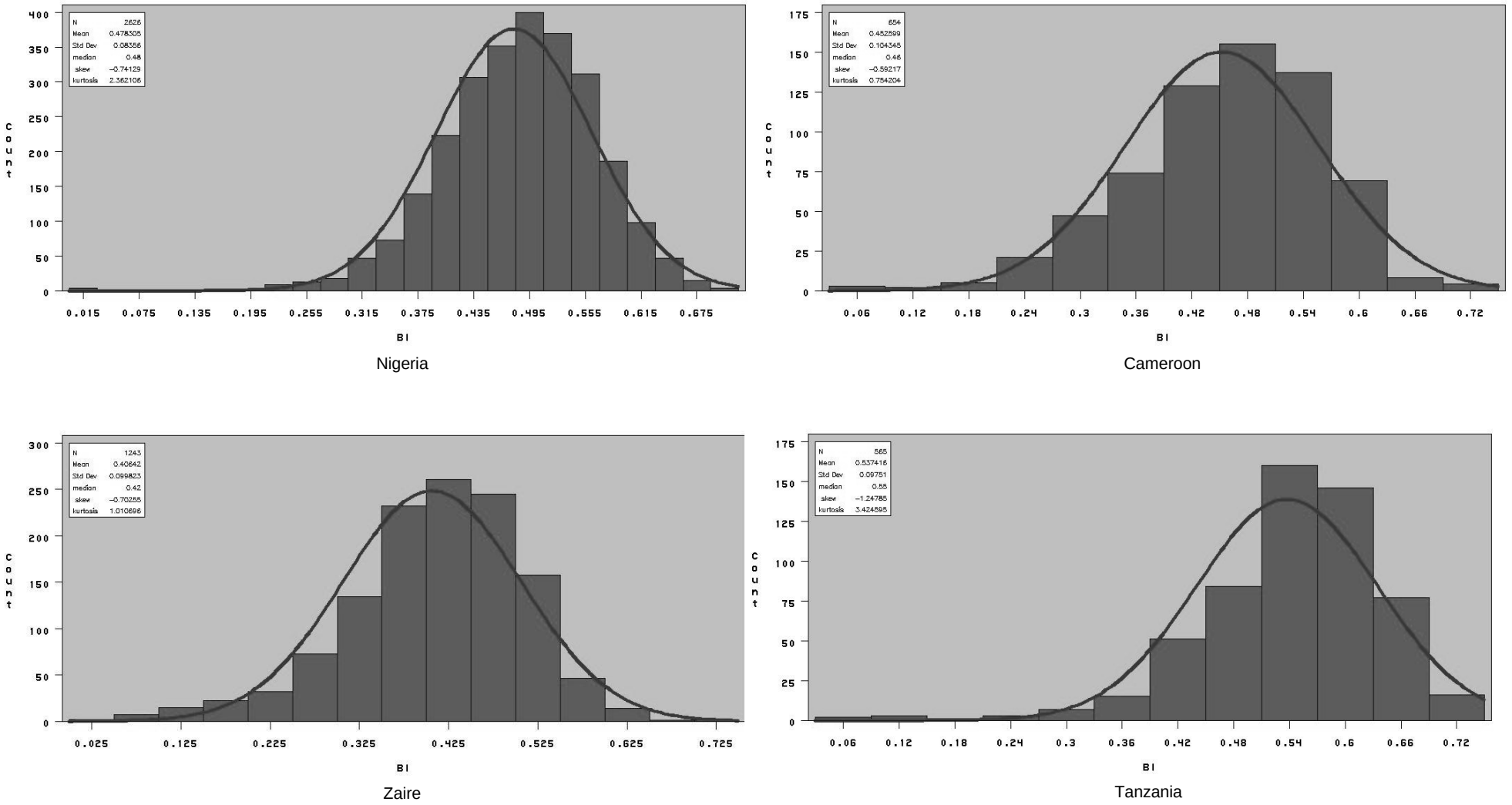
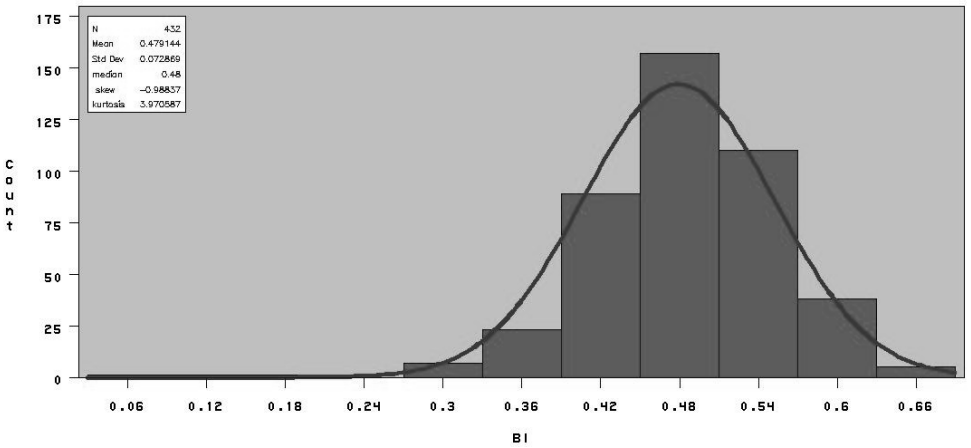
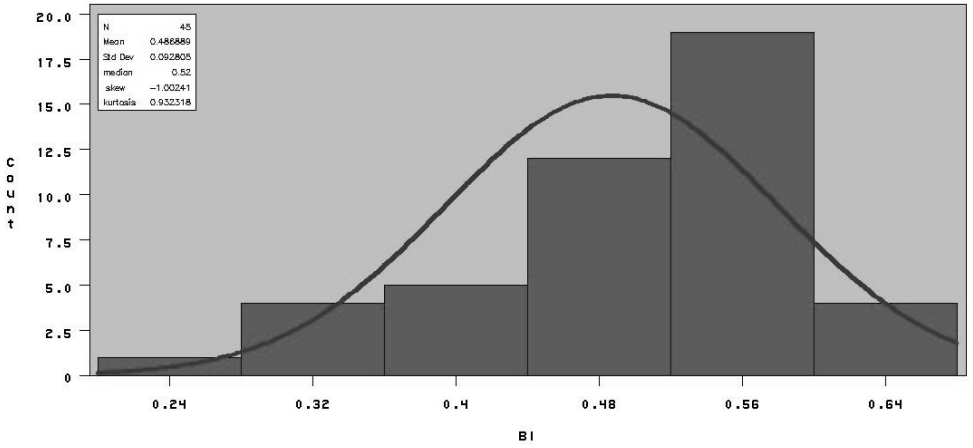


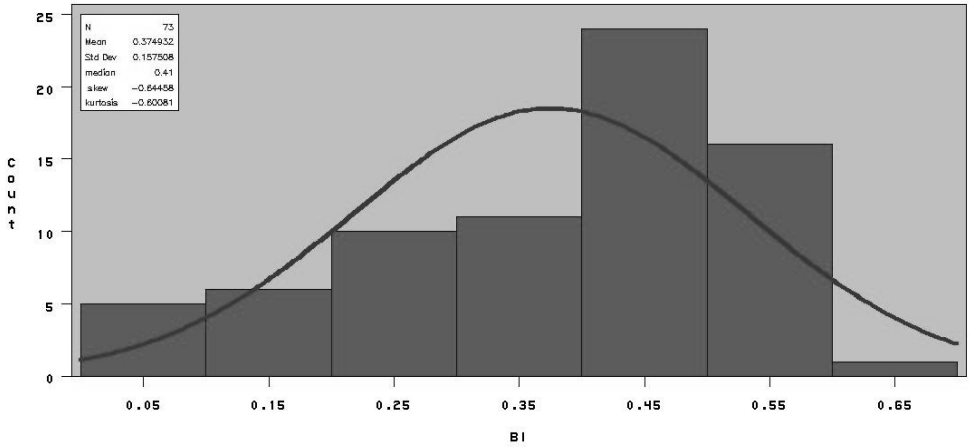

Figure 3: Frequency distribution of BI among *teneras* in Nigeria, Cameroon, Zaire and Tanzania Germplasms



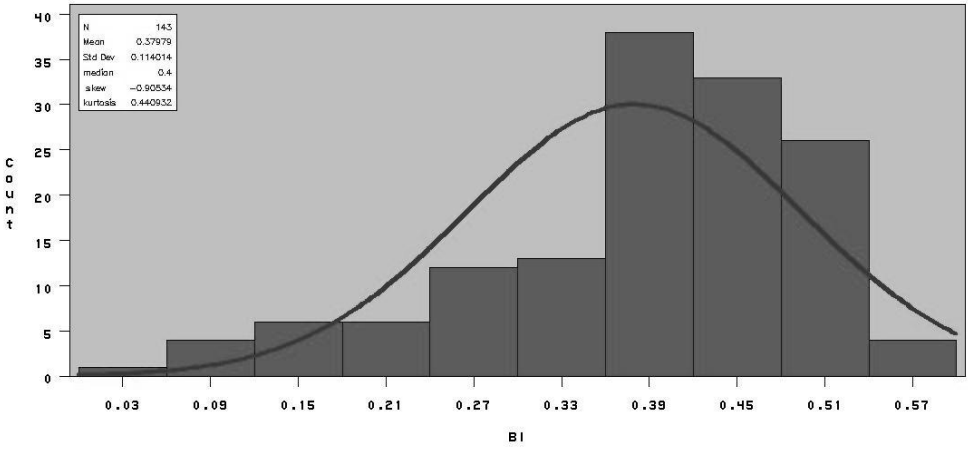

Angola




Sierra Leone




Guinea




Ghana

Figure 4: Frequency distribution of BI among *teneras* in Angola, Sierra Leone, Guinea and Ghana Germplasms

**TABLE 4: MEAN SQUARES, VARIANCE COMPONENTS AND HERITABILITY ESTIMATES FOR BUNCH INDEX OF THE *DURAS* EVALUATED**

| Source | df | NGA | df | CMR | df | ZAR | df | TZA | df | MDG | df | AGO | df | SEN | df | GAM | df | SLE | df | GUI | df | GHA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | 666 | 0.0425** | 90 | 0.0410** | 356 | 0.0347** | 50 | 0.0288** | 10 | 0.0041ns | 51 | 0.0230** | 90 | 0.0677** | 32 | 0.0177** | 51 | 0.0486** | 57 | 0.0560** | 49 | 0.1476** |
| Within Family | 12,572 | 0.0045 | 2,529 | 0.0100 | 7,358 | 0.0089 | 2,000 | 0.0103 | 6 | 0.0025 | 1,890 | 0.0053 | 625 | 0.0085 | 171 | 0.0066 | 785 | 0.0061 | 1,001 | 0.0089 | 2,416 | 0.0096 |
| $\sigma^2_f$ | | 0.0019 | | 0.0011 | | 0.0012 | | 0.0005 | | 0.0011 | | 0.0005 | | 0.0076 | | 0.0018 | | 0.0027 | | 0.0026 | | 0.0028 |
| $\sigma^2_w$ | | 0.0045 | | 0.0100 | | 0.0089 | | 0.0103 | | 0.0025 | | 0.0053 | | 0.0085 | | 0.0066 | | 0.0061 | | 0.0089 | | 0.0096 |
| Total | | 0.0064 | | 0.0111 | | 0.0101 | | 0.0108 | | 0.0036 | | 0.0058 | | 0.0161 | | 0.0084 | | 0.0088 | | 0.0115 | | 0.0124 |
| Heritability ($h^2_B$) | | 59.38% | | 19.82% | | 23.76% | | 9.26% | | 61.11% | | 17.24% | | 94.41% | | 42.86% | | 61.36% | | 45.22% | | 45.16% |

Notes: *, ** Significant at P≤0.05 and P≤0.01, respectively.
NGA = Nigeria, CMR = Cameroon, ZAR = Zaire, TZA = Tanzania, MDG = Madagascar, AGO = Angola, SEN = Senegal, GAM = Gambia, SLE = Sierra Leone,
GUI = Guinea, GHA = Ghana

**TABLE 5: MEAN SQUARES, VARIANCE COMPONENTS AND HERITABILITY ESTIMATES FOR BUNCH INDEX OF THE *TENERAS* EVALUATED**

| Source | df | NGA | df | CMR | df | ZAR | df | TZA | df | AGO | df | SLE | df | GUI | df | GHA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | 414 | 0.0177** | 77 | 0.0174** | 253 | 0.0159** | 50 | 0.0170** | 42 | 0.0073* | 17 | 0.0076ns | 25 | 0.0357* | 33 | 0.0253** |
| Within Family | 2,211 | 0.0050 | 576 | 0.0100 | 989 | 0.0085 | 514 | 0.0088 | 389 | 0.0051 | 27 | 0.0093 | 47 | 0.0190 | 109 | 0.0093 |
| $\sigma^2_f$ | | 0.0020 | | 0.0009 | | 0.0015 | | 0.0008 | | 0.0002 | | 0.0000 | | 0.0063 | | 0.0039 |
| $\sigma^2_w$ | | 0.0050 | | 0.0100 | | 0.0085 | | 0.0088 | | 0.0051 | | 0.0093 | | 0.0190 | | 0.0093 |
| Total | | 0.0070 | | 0.0109 | | 0.0100 | | 0.0096 | | 0.0053 | | 0.0093 | | 0.0253 | | 0.0132 |
| Heritability ($h^2_B$) | | 57.14% | | 16.51% | | 30.00% | | 16.67% | | 7.55% | | 0.00% | | 49.80% | | 59.09% |

Notes: *, ** Significant at P≤0.05 and P≤0.01, respectively. Negative estimate for the variance component for which the most reasonable value is zero.
NGA = Nigeria, CMR = Cameroon, ZAR = Zaire, TZA = Tanzania, AGO = Angola, SLE = Sierra Leone, GUI = Guinea, GHA = Ghana

## CONCLUSION

In MPOB breeding programme, the Tanzanian is known for thin-shelled *tenera* and high bunch index. Besides, some palms from Tanzanian germplasm are also used in long stalk programme. Based on the results presented in this paper, screening of new potential palms will be done to select more palms with high BI. Besides Tanzania, Nigeria and Angola germplasms showed potential as high BI materials.


## ACKNOWLEDGEMENT

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