# EFFECT OF WATER STRESS ON THE YIELD PERFORMANCE OF SEVEN DURA x PISIFERA OIL PALM PROGENIES

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## ABSTRACT

***Seven Dura x Pisifera (DxP) oil palm progenies were evaluated for yield in three climatic locations with different mean annual water deficit (150 mm, 250 mm and 400 mm) values in order to determine their tolerance to water stress. The design used was a randomized complete block in 4 replications with a plot size of 0.48 ha (42 palms). Data was collected on number of bunches and bunch weight (kg) and fresh fruit bunch (FFB) yield (Tonnes/ha) was subsequently calculated. The data was analyzed using Analysis of Variance (ANOVA) and means separated by Duncan's Multiple Range Test (DMRT). Significant progeny effects at each location on the yield parameters were observed and based on these results, three stress tolerant progenies were identified. The identification and selection of drought tolerant progenies for planting in marginal areas and the use of drought sensitive ones in optimum and favourable area in Ghana will lead to efficient utilization of available soil moisture and improvement in overall yields.***

## INTRODUCTION

In tropical regions, rainfall is often one of the main limiting factors for oil palm production (Ochs and Daniel, 1976). The West African oil palm growing belt is characterized by spells of low or no rainfall (Hartley, 1988).

van der Vossen (1969); using values of mean annual water deficits, delineated in broad terms, areas climatically optimum (150 mm water deficit), favourable (250 mm water deficit), and suitable (400 mm water deficit) for economic oil palm cultivation in Ghana.

Several authors have observed the deleterious effect of inadequate water supply (water stress) on plant physiological processes leading to reduced growth and yield in the oil palm (Corley, 1976; Hartley, 1988; Ochs and Daniel, 1976; Ferwerda, 1977; Maillard *et al.*, 1974).

Hartley (1988); however reported that the extent of reduction in growth and yield due to water deficit, and the effectiveness of the plant physiological processes to mitigate the effect of water deficit are determined in part by the genetic makeup of the individual palm or progeny.

Hardon *et al.* (1972), found leaf area to vary with genotype, and in two locations of different water deficit values, Hartley (1988); observed significant height differences among palms of the same genetic origin.

Omore and Nouy (1998); discovered that of all the major yield components, number of bunches is the most sensitive to water deficit variation. This was brought about through the combination of low sex-ratio and abortion of bunches before maturity as a result of water stress.

Maillard *et al.* (1974), observed differences in the severity of drought symptoms between different progenies, and suggested the possibility of selection for drought tolerance.

In Ghana not much work has been done on the consequences of drought on the oil palm, this paper therefore seeks to report on the effect of water stress on the yield performance of seven Dura x Pisifera (DxP) oil palm progenies.

## MATERIALS AND METHODS

Seven Dura x Pisifera (DxP) oil palm progenies (Table 1) were evaluated for yield in three climatic locations with different water deficit regimes from 1986 to 1994.

Location A: Kusi 150 mm water deficit.
Location B: Assin Foso 250 mm water deficit.
Location C: Akumadan 400 mm water deficit.

The experimental design used was randomised complete block in 4 replications comprising a factorial combination of 7 DxP progenies and 3 water deficit regimes. Plot size was approximately 0.28 ha with 42 palms.

### Cultural Practices

At all the three sites, palm interrows were cultivated with *Pueraria phaseoloides* covercrop. 1000-1500 g each of ammonium sulphate, muriate of potash and single superphosphate were applied to each palm in August/September annually at the three locations. 1000 g of magnesium sulphate was applied to each palm every three years. Rings and interrows were slashed at two monthly intervals.

### Yield Recording

The number of bunches and weight of fresh fruit bunches were recorded for individual palms at each harvesting round (weekly) from 1986 to 1994 and weekly yield records compiled into annual records.

### Data Analysis

The data was analysed using analysis of variance (ANOVA) and where significant differences were observed, Duncan's Multiple Range Test (DMRT) used to separate the means.

## RESULTS

Table 2 shows progeny effect at each location on number of bunches per palm per year from 1986 to 1994. Significant differences ($p = 0.05$ and $p = 0.01$) were observed in number of bunches produced by the various progenies at the 3 locations. The highest number of bunches was produced by

**Table 1: Description of Progenies**

| Progeny | Parents | Origin of Parents |
|---|---|---|
| P 1 | 5.12D self x 14.892T self | Deli x (Aba x Angola) |
| P 2 | 5.1225D self x (32.2612T x 32.3005T) | Deli x (Calabar x Aba) |
| P 3 | 5.1080D self x (4.1935T x 15.4382T) | Deli x (Aba x Ufuma) |
| P 4 | 5.1295D self x (32.2612T x 32.3005T) | Deli x (Calabar x Aba) |
| P 5 | (851.215D x 851.255D) x (A-43-24T self) | Deli x Sibiti |
| P 6 | 851.215D x 851.86T (Standard Cross) | Deli x Calabar |
| P 7 | 851.215D self x (1.3056T x 32.3005T) | Deli x (Calabar x Aba) |

**Table 2: Progeny effect at each location on number of bunches/palm/year from 6-14 years after planting (1986 – 1994)**

| Years After Planting | Location | Progenies | | | | | | | Level of significance * P = 0.05 ** P = 0.01 |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 6 (1986) | A | 19.50 | 17.89 | 16.50 | 21.73 | 16.60 | 14.14 | 15.29 | NS |
| | B | 12.81 | 11.70 | 14.98 | 11.70 | 8.54 | 8.98 | 8.09 | ** |
| | C | 3.13 | 4.47 | 3.46 | 4.04 | 5.40 | 3.19 | 3.23 | NS |
| 7 (1987) | A | 15.11 | 15.53 | 16.59 | 14.32 | 10.65 | 11.39 | 10.33 | NS |
| | B | 14.47 | 11.26 | 15.21 | 12.80 | 10.07 | 10.18 | 12.24 | * |
| | C | 6.56 | 3.14 | 5.69 | 4.89 | 3.28 | 3.63 | 3.08 | ** |
| 8 (1988) | A | 12.13 | 9.65 | 10.53 | 11.43 | 7.77 | 8.23 | 10.25 | NS |
| | B | 5.25 | 7.56 | 4.97 | 4.42 | 5.09 | 4.29 | 4.15 | * |
| | C | 4.99 | 4.05 | 3.67 | 5.46 | 3.99 | 4.10 | 4.38 | NS |
| 9 (1989) | A | 15.82 | 13.06 | 12.84 | 13.66 | 18.45 | 10.82 | 10.38 | NS |
| | B | 12.04 | 10.45 | 13.38 | 11.15 | 8.17 | 8.07 | 7.36 | * |
| | C | 5.08 | 3.31 | 4.88 | 4.28 | 4.43 | 3.08 | 5.56 | NS |
| 10 (1990) | A | 9.64 | 9.79 | 10.28 | 10.32 | 6.82 | 7.53 | 8.80 | NS |
| | B | 8.64 | 8.72 | 11.32 | 9.74 | 6.90 | 7.96 | 7.44 | ** |
| | C | 3.44 | 2.97 | 3.58 | 3.39 | 4.57 | 3.24 | 3.05 | NS |
| 11 (1991) | A | 10.83 | 11.76 | 10.05 | 10.91 | 6.54 | 5.92 | 7.17 | ** |
| | B | 6.77 | 8.99 | 8.29 | 7.64 | 5.72 | 5.79 | 4.26 | ** |
| | C | 7.50 | 4.56 | 6.00 | 5.94 | 3.44 | 3.12 | 2.60 | ** |
| 12 (1992) | A | 7.80 | 9.39 | 8.93 | 9.03 | 6.41 | 5.93 | 5.49 | * |
| | B | 5.26 | 6.83 | 6.09 | 6.20 | 2.71 | 4.14 | 3.49 | ** |
| | C | 3.39 | 2.12 | 3.39 | 4.20 | 2.47 | 1.93 | 3.18 | * |
| 13 (1993) | A | 10.94 | 11.21 | 10.59 | 9.49 | 9.15 | 7.82 | 9.10 | NS |
| | B | 8.96 | 10.02 | 11.65 | 10.01 | 5.14 | 5.53 | 6.72 | ** |
| | C | 3.88 | 2.68 | 2.87 | 3.19 | 3.06 | 1.91 | 2.52 | NS |
| 14 (1994) | A | 6.31 | 8.43 | 8.70 | 5.91 | 5.70 | 5.24 | .13 | NS |
| | B | 4.38 | 5.42 | 5.87 | 4.21 | 1.87 | 2.99 | 2.49 | ** |
| | C | 2.08 | 1.73 | 1.84 | 1.95 | 1.06 | 1.63 | 1.95 | NS |

progeny 4 at Kusi whilst the lowest number was produced by progeny 5 at Akumadan.

At Kusi differences were observed in the 11th and 12th year after planting whilst at Assin Foso significant differences in bunch number were recorded in all the nine years of recording (6 -14 years after planting). At Akumadan, differences were recorded in the 7th, 11th and 12th year after planting. Generally number of bunches per palm reduced from Kusi to Akumadan (least water deficit to greatest water deficit) in line with observations made elsewhere.

Table 3 shows progeny effect at each location with respect to bunch weight per palm per year from 1986 to 1994.

The highest total bunch weight per palm per year (226.35 kg) was observed in progeny 1 at Kusi in the 11th year after planting. The lowest total bunch weight per palm (6.76 kg) was recorded in progeny 6 at Akumadan in the 1st year of recording. Again the trend of decreasing bunch weight from Kusi to Akumadan was observed.

Progeny effect on fresh fruit bunches (FFB) yield at the various locations is shown in Table 4. Progeny 1 recorded the highest FFB of 33.5 tonnes/ha this occurred at Kusi in the 11th year after plant-

**Table 3: Progeny effect at each location on bunch weight (kg)/palm/year from 6 – 14 years after planting (1986 – 1994)**

| Years After Planting | Location | Progenies | | | | | | | Level of significance * P = 0.05 ** P = 0.01 |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 6 (1986) | A | 125.14 | 95.41 | 119.80 | 114.31 | 141.08 | 115.07 | 123.11 | NS |
| | B | 66.35 | 54.53 | 68.78 | 57.30 | 67.57 | 56.89 | 124.53 | NS |
| | C | 15.07 | 23.78 | 16.89 | 11.62 | 21.76 | 6.76 | 19.73 | * |
| 7 (1987) | A | 142.43 | 125.00 | 133.65 | 131.22 | 117.84 | 120.20 | 118.18 | NS |
| | B | 108.38 | 74.59 | 111.82 | 89.05 | 101.08 | 89.79 | 132.64 | * |
| | C | 42.50 | 22.91 | 29.05 | 24.79 | 21.42 | 19.39 | 25.54 | ** |
| 8 (1988) | A | 146.62 | 133.18 | 126.55 | 124.12 | 112.43 | 107.29 | 142.29 | * |
| | B | 49.32 | 58.31 | 40.07 | 54.26 | 63.18 | 51.01 | 56.62 | NS |
| | C | 33.24 | 42.29 | 27.97 | 39.32 | 43.72 | 42.16 | 38.85 | NS |
| 9 (1989) | A | 205.21 | 135.68 | 167.43 | 167.23 | 197.84 | 167.16 | 154.45 | NS |
| | B | 128.38 | 103.31 | 145.68 | 121.42 | 118.78 | 105.81 | 127.56 | NS |
| | C | 43.51 | 41.08 | 43.38 | 38.24 | 49.32 | 39.86 | 72.90 | ** |
| 10 (1990) | A | 138.04 | 107.77 | 145.67 | 143.58 | 122.02 | 118.44 | 145.00 | NS |
| | B | 94.45 | 93.98 | 121.48 | 106.55 | 104.72 | 106.89 | 91.41 | NS |
| | C | 40.40 | 38.58 | 43.10 | 38.98 | 55.74 | 36.68 | 35.33 | NS |
| 11 (1991) | A | 226.35 | 163.37 | 172.50 | 167.29 | 169.18 | 148.85 | 131.35 | * |
| | B | 98.64 | 110.06 | 113.37 | 108.64 | 109.79 | 82.56 | 108.51 | NS |
| | C | 95.67 | 74.72 | 81.14 | 74.12 | 52.70 | 51.08 | 47.90 | * |
| 12 (1992) | A | 151.14 | 128.71 | 169.39 | 145.06 | 159.72 | 139.12 | 117.09 | NS |
| | B | 70.67 | 65.00 | 77.09 | 83.31 | 49.86 | 66.62 | 72.90 | * |
| | C | 49.52 | 28.24 | 45.74 | 52.70 | 45.67 | 33.04 | 55.54 | NS |
| 13 (1993) | A | 197.43 | 178.64 | 217.50 | 167.22 | 221.68 | 200.06 | 174.93 | NS |
| | B | 139.05 | 111.14 | 166.08 | 139.66 | 131.35 | 111.14 | 143.71 | * |
| | C | 45.33 | 49.45 | 53.44 | 59.32 | 61.08 | 40.33 | 48.71 | NS |
| 14 (1994) | A | 131.21 | 144.32 | 170.13 | 106.21 | 133.44 | 121.01 | 118.85 | NS |
| | B | 64.52 | 75.94 | 92.70 | 69.39 | 19.77 | 54.93 | 54.05 | * |
| | C | 27.83 | 32.97 | 22.29 | 27.63 | 14.86 | 33.31 | 31.89 | NS |

ing whilst the lowest yield (1.72 tonnes/ha) was obtained from progeny 4 at Akumadan in the 1st year of recording (6th year after planting).

Tables 5a, 5b and 5c show the mean number of bunches/palm/year in the various locations.

Progenies 1, 3, 4 and 2 had the highest bunch production (Table 5a) with progeny 2 being clearly outstanding at Kusi. Progenies 6 and 7 were the poorest bunch producers at Kusi.

At Assin Foso (Table 5b), Progeny 3 was the best bunch producer with progenies 7 and 5 being the poorest.

At Akumadan, (Table 5c) progenies 1 and 4 were outstanding in bunch production while progenies 6 and 7 were mediocre.

Tables 6a - 6c show the mean total bunch weight

**Table 4: Progeny effect at each location on FFB yield/ha/year (Tonnes) from 6 -14 years after planting (1986 – 1994)**

| Years After Planting | Location | Progenies | | | | | | | Level of significance * P = 0.05 ** P = 0.01 |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 6 (1986) | A | 18.52 | 14.12 | 17.73 | 18.14 | 20.88 | 17.03 | 18.22 | NS |
| | B | 9.82 | 8.07 | 10.18 | 8.48 | 10.00 | 8.42 | 18.43 | NS |
| | C | 2.23 | 3.52 | 2.50 | 1.72 | 3.22 | 2.49 | 2.92 | * |
| 7 (1987) | A | 21.08 | 18.50 | 19.78 | 19.42 | 17.44 | 17.79 | 17.49 | NS |
| | B | 16.04 | 11.04 | 16.55 | 13.18 | 14.96 | 13.29 | 19.63 | * |
| | C | 6.29 | 3.39 | 4.30 | 3.67 | 3.17 | 2.87 | 3.78 | ** |
| 8 (1988) | A | 21.70 | 19.71 | 18.73 | 18.37 | 16.64 | 15.88 | 21.06 | * |
| | B | 7.30 | 8.63 | 5.93 | 8.03 | 9.35 | 7.55 | 8.38 | NS |
| | C | 4.92 | 6.26 | 4.14 | 5.82 | 6.47 | 6.24 | 5.75 | NS |
| 9 (1989) | A | 30.37 | 20.08 | 24.78 | 24.75 | 29.28 | 24.74 | 22.86 | NS |
| | B | 19.00 | 15.29 | 21.56 | 17.97 | 17.58 | 15.66 | 18.88 | NS |
| | C | 6.44 | 6.08 | 6.42 | 5.66 | 7.30 | 5.90 | 10.79 | ** |
| 10 (1990) | A | 20.43 | 15.95 | 21.26 | 21.25 | 18.06 | 17.53 | 21.46 | NS |
| | B | 13.98 | 13.91 | 17.98 | 15.77 | 15.50 | 15.82 | 13.53 | NS |
| | C | 5.98 | 5.71 | 6.38 | 5.77 | 8.25 | 5.43 | 5.23 | NS |
| 11 (1991) | A | 33.50 | 24.18 | 25.53 | 24.76 | 25.04 | 22.03 | 19.44 | * |
| | B | 14.60 | 16.29 | 16.78 | 16.08 | 16.25 | 12.22 | 16.06 | NS |
| | C | 14.16 | 11.06 | 12.01 | 10.97 | 7.80 | 7.56 | 7.09 | * |
| 12 (1992) | A | 22.37 | 19.05 | 25.07 | 21.47 | 23.64 | 20.59 | 17.33 | NS |
| | B | 10.46 | 9.62 | 11.41 | 12.33 | 7.38 | 9.86 | 10.79 | * |
| | C | 7.33 | 4.18 | 6.77 | 7.80 | 6.76 | 4.89 | 8.22 | NS |
| 13 (1993) | A | 29.22 | 26.44 | 32.19 | 24.75 | 32.81 | 29.61 | 25.89 | NS |
| | B | 20.58 | 16.45 | 24.58 | 20.67 | 19.44 | 16.45 | 21.27 | * |
| | C | 6.71 | 7.32 | 7.91 | 8.78 | 9.04 | 5.97 | 7.21 | NS |
| 14 (1994) | A | 19.42 | 21.36 | 25.18 | 15.72 | 19.75 | 17.91 | 17.59 | NS |
| | B | 9.55 | 11.24 | 13.72 | 10.27 | 6.59 | 8.13 | 8.00 | * |
| | C | 4.12 | 4.88 | 3.30 | 4.09 | 2.20 | 4.93 | 4.72 | NS |

**Table 5a: Mean number of bunches/palm/year at location A (Kusi)**

| Year 11 (1991) | | Year 12 (1992) | |
|---|---|---|---|
| Progeny 6 | 5.9200 c | Progeny 7 | 5.4900 c |
| 5 | 6.5375 c | 6 | 5.9275 bc |
| 7 | 7.1650 bc | 5 | 6.4100 abc |
| 3 | 10.0500 ab | 1 | 7.8025 abc |
| 1 | 10.8275 a | 3 | 8.9275 ab |
| 4 | 10.9175 a | 4 | 9.0250 ab |

*Means in a column bearing the same letters are not significantly different at P = 0.05.*

**Table 5b: Mean number of bunches/palm/year at location B (Assin-Foso)**

| Years After Planting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 (1986) | 7(1987) | 8 (1988) | 9 (1989) | 10 (1990) | 11 (1991) | 12 (1992) | 13 (1993) | 14 (1994) |
| P7: 8.0900 c | P5: 10.0650 c | P7: 4.1450 b | P7: 7.3350 c | P5: 6.9000 c | P7: 4.2600 d | P5: 2.7125 d | P5: 5.1400 c | P5: 1.8700 c |
| P5: 8.5375 bc | P6: 10.1825 c | P6: 4.2850 b | P6: 8.0725 bc | P7: 7.4425 bc | P5: 5.7200 cd | P7: 3.4850 cd | P6: 5.5250 c | P7: 2.4925 c |
| P6: 8.9800 bc | P2: 11.2550 bc | P4: 4.4200 b | P5: 8.1650 bc | P6: 7.9625 bc | P6: 5.7850 cd | P6: 4.1375 bcd | P7: 6.7175 bc | P6: 2.9900 bc |
| P4: 11.7000 ab | P7: 12.2400 abc | P3: 4.9725 b | P2: 10.4525abc | P1: 8.6350 bc | P1: 6.7700 bc | P1: 5.2600 abc | P1: 8.9575 ab | P4: 4.2100 ab |
| P2: 11.7000 ab | P4: 12.8050 abc | P5: 5.0875 b | P4: 11.1450abc | P2: 8.7200 bc | P4: 7.6400 abc | P3: 6.0900 ab\ | P4: 10.0075 a | P1: 4.3825 ab |
| P1: 12.8050 a | P1: 14.4725 ab | P1: 5.2450 b | P1: 12.0350 ab | P4: 9.7400 ab | P3: 8.2900 ab | P4: 6.1950 ab | P2: 10.0225 a | P2: 5.4150 a |
| P3: 14.9825 a | P3: 15.2200 a | P2: 7.5625 a | P3: 13.3800 a | P3: 11.3200 a | P2: 8.9850 a | P2: 6.8250 a | P3: 11.6450 a | P3: 5.8700 a |

**Means in a column bearing the same letters are not significantly different at P = 0.05**

**Table 5c: Mean number of bunches/palm/year in location C (Akumadan)**

| Year 7 (1987) | Year 11 (1991) | Year 12 (1992) |
|---|---|---|
| P7: 3.0825 c | P7: 2.6000 c | P6: 1.9250 b |
| P2: 3.1400 c | P6: 3.1200 c | P2: 2.1150 b |
| P5: 3.2775 c | P5: 3.4450 c | P5: 2.4700 b |
| P6: 3.6300 bc | P2: 4.5600 bc | P7: 3.1750 ab |
| P4: 4.8925 abc | P4: 5.9375 ab | P1: 3.3850 ab |
| P3: 5.6875 ab | P3: 6.0000 ab | P3: 3.3900 ab |
| P1: 6.5550 a | P1: 7.4950 a | P4: 4.2025 a |

*Means in a column bearing the same letters are not significantly different at P = 0.05*

per palm per year in the various locations. At Kusi (Tables 6a) progeny 1 produced the highest total bunch weight per palm of 146.62 kg and 226.35 kg in the 8th and 11th year after planting respectively. Progeny 7 produced the lowest bunch weight (131.35 kg) at Kusi.

At Assin-Foso progeny 3 produced the highest total bunch weight per palm of 166.08 kg and 92.70 kg in the 13th and 14th year after planting respectively with progeny 5 giving the lowest bunch weight per palm in the 14th year (Table 6 b).

The situation at Akumadan (Table 6c) was similar to what prevailed at Kusi. Progeny 1 was outstanding in total bunch weight per palm (95.68 kg) followed by progeny 3 (81.15 kg) in the 11th year after planting. Progeny 7 again produced the lowest total bunch weight at Akumadan in the 11th year after planting.

Tables 7a – 7c show mean FFB yield per hectare per year at the various locations. Progeny 1 produced the highest FFB (33.5 tons/ha). This occurred at Kusi (Table 7a) and was significantly higher (p = 0.05) than all the other progenies.

At Assin-Foso (Table 7b) progeny 3 was the best FFB producer ((24.6 tonnes/ha).

Progeny 1 was again the highest FFB producer at Akumadan (Table 7c) with 14.2 tons/ha. This was significantly (p = 0.05) higher than all the others.

**Table 6a: Bunch weight (kg) /palm/year in location A (Kusi)**

| Year 8 (1988) | Year 11 (1991) |
|---|---|
| P6: 107.2973 b | P7: 131.3514 b |
| P5: 112.4324 b | P6: 148.8514 b |
| P4: 124.1216 ab | P2: 163.3783 b |
| P3: 126.5541 ab | P4: 167.2973 ab |
| P2: 133.1757 ab | P5: 169.1892 ab |
| P7: 142.2973 a | P3: 172.5000 ab |
| P1: 146.6216 a | P1: 226.3514 a |

*Means in a column bearing the same letters are not significantly different at P = 0.05*

**Table 6b: Bunch weight (kg) /palm/year in location B (Assin-Fosu)**

| Year 7 (1987) | Year 12 (1992) | Year 13 (1993) | Year 14 (1994) |
|---|---|---|---|
| P2: 74.5946 b | P5: 49.8649 b | P2: 111.1486 b | P5: 19.7780 c |
| P4: 89.0541 b | P2: 65.0000 ab | P6: 111.1486 b | P7: 54.0541 bc |
| P6: 89.7973 b | P6: 66.6216 ab | P5: 131.3514 ab | P6: 54.9324 bc |
| P5: 101.0811 ab | P1: 70.6757 ab | P1: 139.0541 ab | P1: 64.5270 bc |
| P1: 108.3784 ab | P7: 72.9054 ab | P4: 139.6621 ab | P4: 69.3919 b |
| P3: 111.8243 ab | P3: 77.0946 ab | P7: 143.7162 ab | P2: 75.9459 ab |
| P7: 132.6351 a | P4: 83.3108 a | P3: 166.0811 a | P3: 92.7027 a |

*Means in a column bearing the same letters are not significantly different at P = 0.05*

**Table 6c: Bunch weight (kg) /palm/year in location C (Akumadan)**

| Year 6 (1986) | Year 7 (1987) | Year 9 (1989) | Year 11 (1991) |
|---|---|---|---|
| P4: 11.6216 b | P6: 19.3919 b | P4: 38.2432 b | P7: 47.9054 c |
| P1: 15.0676 ab | P5: 21.4189 b | P6: 39.8649 b | P6: 51.0811 bc |
| P6: 16.8243 ab | P2: 22.9054 b | P2: 41.0811 b | P5: 52.7027bc |
| P3: 16.8919 ab | P4: 24.7973 b | P3: 43.3784 b | P4: 74.1216 abc |
| P7: 19.7297 ab | P7: 25.5405 b | P1: 43.5135 b | P2; 74.7297 abc |
| P5: 21.7568 ab | P3: 29.0541 b | P5: 49.3243 b | P3: 81.1486 ab |
| P2: 23.7838 a | P1: 42.5000 a | P7: 72.9054 a | P1: 95.6757 a |

*Means in a column bearing the same letters are not significantly different at P = 0.05*

**Table 7a: Mean FFB yield (Tonnes)/ha/year in location A (Kusi)**

| Year 8 (1988) | Year 11 (1991) |
|---|---|
| P6: 15.8800 b | P7: 19.4400 b |
| P5: 16.6400 b | P6: 22.0250 b |
| P4: 18.3725 ab | P2: 24.1825 b |
| P3: 18.7275 ab | P4: 24.7575 ab |
| P2: 19.7075 ab | P5: 25.0425 ab |
| P7: 21.0625 a | P3: 27.5275 ab |
| P1: 21.6950 a | P1: 33.4950 a |

*Means in a column bearing the same letters are not significantly different at P = 0.05*

**Table 7b: Mean FFB yield (Tonnes)/ha/year in location B (Assin-Fosu)**

| Year 7 (1987) | Year 12 (1992) | Year 13 (1993) | Year 14 (1994) |
|---|---|---|---|
| P2: 11.0400 b | P5: 7.3875 b | P2: 16.4450 b | P5: 6.5875 c |
| P4: 13.1825 b | P2: 9.6200 ab | P6: 16.4525 b | P7: 8.0000 bc |
| P6: 13.2850 b | P6: 9.8575 ab | P5: 19.4425 ab | P6: 8.1325 bc |
| P5: 14.9550 ab | P1: 10.4550 ab | P1: 20.5800 ab | P1: 9.5500 bc |
| P1: 16.0425 ab | P7: 10.7875 ab | P4: 20.6725 ab | P4: 10.2675 b |
| P3: 16.5450 ab | P3: 11.4125 ab | P7: 21.2675 ab | P2: 11.2350 ab |
| P7: 19.6250 a | P4: 12.3300 a | P3: 24.5750 a | P3: 13.7150 a |

*Means in a column bearing the same letters are not significantly different at P = 0.05*

**Table 7c: Mean FFB yield (Tonnes)/ha/year in location C (Akumadan)**

| Year 6 (1986) | Year 7 (1987) | Year 9 (1989) | Year 11 (1991) |
|---|---|---|---|
| P4: 1.7225 b | P6: 2.8650 b | P4: 5.6600 b | P7: 7.0850 c |
| P1: 2.2275 ab | P5: 3.1725 b | P6: 5.9025 b | P6: 7. 5550 bc |
| P6: 2.4850 ab | P2: 3.3850 b | P2: 6.0775 b | P5: 7.7950 bc |
| P3: 2.4975 ab | P4: 3.6700 b | P3: 6.4225 b | P4: 10.9725 abc |
| P7: 2.9225 ab | P7: 3.7825 b | P1: 6.4375 b | P2: 11.0625 abc |
| P5: 3.2200 ab | P3: 4.3000 b | P5: 7.3025 b | P3: 12.0050 ab |
| P2: 3.5175 a | P1: 6.2900 a | P7: 10.7900 a | P1: 14.1575 a |

Means in a column bearing the same letters are not significantly different at P = 0.05