Updates on the Evaluation of Semi-clonal DXP Progenies in Sime Darby[1]

Mohaimi Mohamed[1]

1. Sime Darby R&D Centre, Km 10 Jalan Banting-Kelanang, 42700 Banting, Selangor, Malaysia

Abstract

Sime Darby has initiated clonal seed evaluation since the early 1980's as one of the DXP planting material improvement programmes. The latest evaluation of the semiclonal DXP indicated that semiclonal seed production will not be far from commercialisation and can be the common oil palm planting material in the near future. The clonal CD484 durawas tested with Ekona and AVROS pisiferas, and five years of recoding indicated that Ekona pisiferas were more compatible with CD484 duras compared with AVROS pisiferas tested. Semiclonal DXP progenies were observed to be precocious and high yielding and comparable with the DXP control, and can potentially produce average oil yield of 9.1 tonnes/hectare/year. The progenies produced were also found to have lower variability on some of the oil content related characters, and there were no mantled fruits or other abnormalities detected in the semiclonal progenies at the end of the 5 years evaluation period. The clonal seed programmes will not interfere with the current clonal production and the clonal seeds may transform the current commercial DXP seed production and tissue culture will be an important technique for the production of commercial oil palm planting material in the future. This paper reports the latest results of semi-clonal DXP planting materials in Sime Darby.

[1] Paper presented at the International *Seminar on Breeding for Sustainability in Oil Palm, held on* 18 November 2011 in Kuala Lumpur, Malaysia. Jointly organised by the International Society for Oil Palm Breeders (ISOPB) and Malaysian Palm Oil Board (MPOB). P. 125 -135

Introduction

Oil palm has been successfully propagated by tissue culture and was reported at1976 Malaysian Agricultural Oil Palm Conference by Corley et al (1970).Subsequently, Unipamol Malaysia Sdn. Bhd. has brought in bare-rooted clonal oil palm planting materials produced by Unilever in Bedford, United Kingdom and these were planted in June 1977 in Pamol Estate, Kluang as trial PCT1. This early success in the propagation and planting has inspired many oil palm plantation companies to embark onoil palm tissue culture. However, the development of this new promising technique has been almost brought to a halt by the occurrence of abnormalities reported from the early plantings of the tissue culture clones.

There are a few limitations observed in the clonal palm production,mainly the abnormalities, the cost involved and high genotype x environment interactions of the clonal materials. As an alternative approach, mass propagation of parents by tissue culture for DXP seed production will be one of the strategies to produce elite DXP planting materials (Rajanaidu et al, 1997) where the technique can be utilised to produce seeds with the dura or/and pisifera clones as the parents for commercial DXP seed production. The most sensible and economical choice is to produce semi-clonal seed from cloned dura parents where large number of selected elite duras can be multiplied to produce more uniform DXP planting materials and with less significant genotype x environment interactions compared with clonal planting materials (Corley et al, 1992).

Sime Darby has initiated the clonal seed programmes since the early 1980’s and evaluation of clonal seeds as the DXP planting materials has been carried out ever since.

Materials and Methods

Crossing Programmes

The evaluation of semi-clonal DXP seeds was first reported earlier by Veerappan et al. (2000) utilising CD484 dura clones that originated from an embryo culture initiated in mid-1980s and planted in breeding trial TC/PT/10. Eighty CD484 clones were also planted in trial TC/PT/4 in 1988 and 12 (357, 364, 373, 374, 1109, 1095, 1098, 1115, 1793, 1810, 2216 and 2217) individuals were selected for progeny testing. Currently, 6 of these progeny tested CD484 duras (357, 374, 1095, 1098, 1115 and 1793) were selfed and planted in three trials for future programmes.

CD484 durawas selected from trial TC/PT/4 in Sg. Buloh Estate and was progeny tested with 2Ekona and 2 AVROS pisiferas in breeding trial BO/PT/27.1. The list of semiclonal progenies evaluated is summarized in Table 1 below.

Table 1: The list of progenies evaluated in Trial BO/PT/27.1

No.	Progeny Code	Female	x	Male
1	4067	PT 4.357	x	Ekona 1
2	4043	PT 4.364	x	Ekona 1
3	4058	PT 4.374	x	Ekona 1
4	4052	PT 4.373	x	Ekona 1
5	4044	PT 4.1095	x	Ekona 1
6	4068	PT 4.1098	x	Ekona 1
7	4013	PT 4.1109	x	Ekona 1
8	4046	PT 4.1115	x	Ekona 1
9	4019	PT 4.1793	x	Ekona2
10	4072	PT 4.1810	x	Ekona 1
11	4064	PT 4.2216	x	Ekona 1
12	4048	PT 4.2217	x	Ekona 1
13	4045	PT 4.364	x	AVROS 1
14	4053	PT 4.373	x	AVROS 1
15	4049	PT 4.1095	x	AVROS 1
16	4061	PT 4.1115	x	AVROS 1
17	4063	PT 4.2216	x	AVROS 1
18	4062	PT 4.2217	x	AVROS 1

Field Evaluation

The progeny testing of this semi-clonal DXP was planted in Rubana Estate in May 2002 and the experiment was laid out in RCBD in 5 blocks at 4 palms/plot. The trial was planted on Briah Series soilat 180 palms stand per hectare (S.P.H.) as part of the high density planting suitability evaluation for these semi-clonal DXP planting materials. Yield recording was carried out from May 2005 to April 2010 and bunch analysis was carried out from April 2006 to November 2010.

Results and Discussions

Yield and Yield Components

The yield and yield components recorded are shown in Table 2. Generally, all semi-clonal DXP progenies were observed to be precocious and high yielding. The data obtained showed that semi-clonal DXP progenies were comparable to the DXP control with the mean FFB yield from 2005 to April 2010 of 183.5 kg/palm/year (33.0 mt/ha/year) with highest FFB yield was recorded by progeny 4048 with 207.2

kg/palm/year (37.3 mt/ha/year) and 109% higher than the DXP control. High FFB yield per hectare in the semiclonal DXP progenies evaluated was partly due to the high density planting of 180 S.P.H. adopted. There was no adverse effect observed on the performance of these semiclonal materials due to the planting density.

Variance analysis showed that there were highly significant differences in FFB yield and bunch number between the semiclonal DXP progenies, however, the average bunch weight was not significantly different indicating the semi-clonal DXP progenies have comparable FFB yield and bunch formation with the DXP control. Most of the semiclonal progenies evaluated produced FFB yield comparable to DXP control (Table 2).

Table 2: Yield and Yield Components of Semiclonal DXP Progenies Originated from CD484

Item	**df**		**Mean Squares**			
			FFB (t/ha/yr)	**FFB (kg/palm)**	**BNO**	**BWT (kg)**
Block	4		35.8^{ns}	1106.5^{ns}	47.8^{ns}	6.5^{ns}
Progeny	18		164.9**	5087.9**	78.0**	4.4^{ns}
Error	329		41.9	1293.2	15.1	2.3
Progeny Code	**Parents**		**FFB (t/ha/yr)**	**FFB (kg/palm)**	**BNO**	**BWT (kg)**
	Female	**Male**				
4048	PT4.2217	Ekona 1	37.3^{a}	207.2^{a}	21.9^{abcd}	9.7^{ab}
4046	PT4.1115	Ekona 1	36.9^{a}	205.1^{a}	23.3^{a}	8.9^{bc}
4058	PT4.374	Ekona 1	36.5^{a}	202.9^{a}	22.2^{abc}	9.1^{abc}
4067	PT4.357	Ekona 1	35.8^{ab}	199.0^{ab}	22.5^{ab}	8.9^{bc}
4013	PT4.1109	Ekona 1	35.5^{abc}	197.1^{abc}	22.5^{ab}	8.8^{bc}
4044	PT4.1095	Ekona 1	35.4^{abc}	196.6^{abc}	22.5^{ab}	8.9^{bc}
4043	PT4.364	Ekona 1	35.1^{abc}	195.0^{abc}	22.8^{a}	8.6^{bc}
4072	PT4.1810	Ekona 1	34.5^{abcd}	191.9^{abcd}	21.9^{abcd}	8.9^{bc}
4052	PT4.373	Ekona 1	34.4^{abcd}	191.1^{abcd}	21.6^{abcd}	9.0^{bc}
4019	PT4.1793	Ekona 2	33.4^{abcde}	185.7^{abcde}	21.2^{abcd}	8.6^{bc}
4068	PT4.1098	Ekona 1	33.3^{abcde}	185.4^{abcde}	20.4^{abcde}	9.1^{abc}
4049	PT4.1095	AVROS 1	31.4^{bcdef}	174.3^{bcdef}	19.4^{cdefg}	9.1^{abc}
4053	PT4.373	AVROS 1	30.6^{cdef}	169.7^{cdef}	18.2^{efg}	9.3^{ab}
4062	PT4.373	AVROS 1	30.5^{cdef}	169.3^{cdef}	19.0^{defg}	9.0^{bc}
4064	PT4.2216	Ekona 1	29.7^{def}	164.9^{def}	19.7^{bcdef}	8.0^{c}
4045	PT4.364	AVROS 1	29.4^{ef}	163.2^{ef}	17.3^{fg}	9.6^{ab}
4061	PT4.1115	AVROS 1	28.4^{f}	157.9^{f}	16.8^{g}	9.6^{ab}

4063	PT4.2216	AVROS 1	28.1^{f}	156.0^{f}	18.3^{efg}	8.8^{bc}
Mean			33.0	183.5	20.6	9.0
CV (%)			21.3	39.1	4.3	1.6
F-value			3.9**	3.9**	5.2**	1.9^{ns}
5041	DXP Control		34.2^{a}	190.1^{a}	19.1^{b}	10.2^{a}

Means with the same letter are not significantly different
* - Significant at 5% level
** - Significant at 1% level
NS - Not significant

Comparison of the yield and yield components between Ekona and AVROS progenies in the trial showed that semiclonal Ekona DXP progenies produced comparable FFB yield and bunch number compared to DXP control. The high FFB yield in semiclonal Ekona DXP progenies was contributed by high bunch number (Table 3). The results indicated that CD484 clonal duras were more compatible with Ekona pisiferas for the semiclonal DXP production.

Table 3 : Yield and Yield Components Comparison Between Semiclonal DXP of Ekona and AVROS PisiferaProgenies

Item	df	Mean Squares			
		FFB t/ha/yr	FFB (kg/palm)	BNO	BWT (kg)
Block	4	35.8^{ns}	1106.5^{ns}	47.8^{ns}	6.5^{ns}
	1	1613.4**	49770.7**	1076.2**	24.7^{ns}
Error	346	43.7	1350.5	15.3	2.4

Group	Mean			
	FFB t/ha/yr	FFB (kg/palm)	BNO	BWT (kg)
CD484 X Ekona	34.8^{a}	193.1^{a}	21.9^{a}	8.9^{b}
CD484 X AVROS	30.4^{b}	168.7^{b}	18.3^{b}	9.4^{a}
Mean	33.1	183.8	20.5	9.1
CV (%)	21.0	21.0	21.1	17.4
F-value	36.9**	36.9**	70.3**	10.4^{ns}
DxP Control	34.2	190.1	19.1	10.2

Means with the same letter are not significantly different
* - Significant at 5% level
** - Significant at 1% level
NS - Not significant

Bunch Analysis

Bunch analysis results confirmed the earlier observation on the fruit formation compared to the DXP control. The fruit-to-bunch, shell-to-fruit, mesocarp-to-fruit, oil-to-dry mesocarp, oil-to-wet mesocarp and oil-to-bunch ratios showed no significant difference between semiclonal and the DXP control indicating good bunch formation and characteristics of the semiclonal DXP progenies (Table 5).There is no mantled fruit or abortive bunches or other abnormalities detected in the semiclonal progenies evaluated in the recent survey at the end of five years of evaluation.

There were also significant differences observed between the Ekona and AVROS pisifera progenies in the trial. Ekona semiclonal progenies had a significantly higher oil per palm and oil per hectare compared with AVROS progenies, mainly contributed by the significantly higher FFB yield compared to semiclonal AVROS progenies. Semiclonal AVROS progenies had a significantly higher mean fruit weight, kernel-to-fruit, kernel-to-bunch and oil-to-dry mesocarp ratios compared with the semiclonal Ekona progenies. The coefficient of variation for fruit-to-bunch, oil-to-wet mesocarp, oil-to-dry mesocarp and mesocarp-to-fruit ratios were found to be below 9%, indicating low variability observed in these characteristics.

Discussion

The Ekona pisifera tested has the potential to be utilized for the production of semi-clonal DXP and it is more compatible with CD484 clonal duras compared with the AVROS pisiferas in terms of FFB yield and bunch number. Higher coefficient of variation observed on some of the parameters compared with the previous Sime Darby semiclonal evaluation reported by Veerappan et al. (2000) was due to the statistical analysis being carried out using an individual palm data.

The high density planting still showed no adverse effect on the FFB yield and bunch number after five years of harvesting. Adoption of planting density of 180 palms per hectare for these semiclonal DXP progenies can potentially produce average oil yield of 9.1 tonnes/hectare/year and suitability of these progenies to the high density planting is still being evaluated. The semiclonal DXP progenies were also found to have lower variability on some of the oil content related characteristics.

Work on developing parental materials through clonal technique will complement conventional breeding and seed production. It is envisaged that the production of parents for commercial oil palm seeds is the next breakthrough in the tissue culture technology utilisation. Instead of just producing clones, the cloning and planting of the parents can be carried out concurrently with breeding improvement programmes. Superior oil yield and more uniform planting material can be obtained with the semiclonal DXP and the results obtained will enable us to move forward towards producing semiclonal DXP planting material in addition to the production of clonal planting materials.

Conclusion

The high cost of tissue culture propagation can be justified with the inclusion of the production of high value clonal parents for commercial DXP seed production. The utilisation of tissue culture technology in the production of oil palm planting materials is expected to open the new era for diversification in the utilisation of tissue culture technology. This can provide a renewed interest in this technology, investment and research towards tissue culture technology advancement.

The clonal seed programmes will not substitute the production of clonal planting materials but there is great potential in the clonal seed programme to complement the current commercial DXP seed production. Tissue culture technology will play an important role in the propagation of good parents for commercial oil palm planting material in the future.

Acknowldgement

The author would like to express acknowledge En. Musa Bilal who initiated and supervised the early stages of thisexperiment. The author also would like to thank Messrs. Veerappan, Musa Bilal, Dr Mohamed Nazeeb and Loong Sing Guan in initiating the CD484 evaluation and realizing the potential of semiclonal DXP as the future planting materials.

The author would also like to record his deepest appreciation to Sime Darby Plantation Sdn Bhd for permission to publish this paper.

References

Corley, R.H.V., Barrett, J.N. and Jones, L.H. (1976) Vegetative Propagation of Oil Palm via Tissue Culture. *In* Malaysian Agricultural Oil Palm Conference, Kuala Lumpur 1976.

Corley, R.H.V. (1998). What is the Upper Limit to Oil Extraction Ratio? *In* Proc. Oil and Kernel Production in Oil Palm - A Global Perspective.Palm Oil Res. Inst. Malaysia. 256 – 269.

Hardon, J.J., Corley, R.H.V. and Lee, C.H. (1982) Breeding and Selection for Vegetative Propagation in the Oil Palm.*In* Improvement of Vegetatively Propagated Crops. London 1987.

Jones, L.H. (1974) Propagation of clonal oil palm by tissue culture. Oil Palm News. 17: 1 – 8.

Khaw, C.H. and Ng, S.K. (1997) Performance of Commercial Scale Clonal Oil Palm (*Elaeisguineensis*Jacq.)Planting in Malaysia. Intl. Soc. Of Horticultural Science Symposium. Brisbane, Autralia. 8pp.

Rajanaidu, N. Rao, V. Halim, A.H. and Ong, S. H. (1990) Genetic Resources : New Developments in Oil Palm Breeding. *Elaeis* 1: 1-10.

Sharma, M. And Tan, Y.P. (1999) Oil Palm Breeding Programmes and the Performance of DXP Planting Materials at United Plantations Berhad.*In* Proc. Seminar on Sourcing of Oil Palm Planting Materials for Local and Overseas Joint Venture.Rajanaidu, N. And Jalani, B.S. (Eds.) Palm Oil Res. Inst. Malaysia. 118-135.

Simon, S. And Koh, H. L. (2005) An Update on Performance of Tissue Cultured Oil Palm Clones in PBB Oil Palms Bhd. – East Malaysia. *In* Proc. 2005 Nat. Sem. Practices Super High Yielding Plantation. Malaysia Palm Oil Board, Kuala Lumpur.

Soh, A.C. (1986) Expected Yield Increase with Selected Oil Palm Clones from Current DXP Seedling Materials and it's Implications on Clonal Propagation, Breeding and Ortet Selection. Oleagineux. 41: 51-56.

Veerappan, P. Musa Bilal, Mohamed Nazeeb, Loong Sing Guan (2000) Early Performance and Potential of Semiclonal DXP Progenies. *In* International Planters Conference, Kuala Lumpur.

Table 5 : Bunch Components Comparison Between Semiclonal DXP Progenies

Item	df	Mean Squares										
		F/B%	MFW%	M/F%	S/F%	K/F%	O/DM%	O/WM%	O/B%	K/B%	O/P (kg)	O/Ha (m/ton)
Block	4	7.4^{ns}	3.6^{ns}	14.7^{ns}	4.4^{ns}	6.6^{ns}	40.0^{ns}	22.3^{ns}	5.9^{ns}	1.7^{ns}	38.3^{ns}	1.2^{ns}
Progeny	18	50.2^{ns}	13.1**	65.4**	7.1^{ns}	45.3**	22.1^{ns}	15.5^{ns}	21.7^{ns}	17.8**	512.2**	16.6**
Error	270	29.4	4.2	13.0	4.5	3.9	13.6	14.4	9.1	2.2	93.9	3.0

Progeny Code	Parents		F/B%	MFW%	M/F%	S/F%	K/F%	O/DM%	O/WM%	O/B%	K/B%	O/P (kg)	O/Ha (m/ton)
	Female	Male											
4067	PT4.357	Ekona 1	65.6^{a}	9.5^{ef}	81.5^{ab}	10.1^{ab}	8.3^{bc}	72.5^{abcd}	47.0^{abc}	25.1^{abc}	5.3^{c}	49.9^{ab}	9.0^{ab}
4068	PT4.1098	Ekona 1	69.2^{a}	9.5^{ef}	82.6^{a}	9.2^{abc}	8.3^{bc}	72.4^{abcd}	44.6^{c}	25.5^{abc}	5.7^{c}	50.6^{ab}	9.1^{ab}
4046	PT4.1115	Ekona 1	66.9^{a}	10.1^{cdef}	82.4^{a}	9.6^{abc}	8.1^{bc}	72.6^{abcd}	46.3^{abc}	25.5^{abc}	5.2^{c}	52.2^{ab}	9.4^{ab}
4061	PT4.1115	AVROS 1	65.7^{a}	11.2^{abcde}	78.9^{bcd}	10.2^{ab}	10.9^{a}	73.3^{abc}	45.9^{abc}	23.7^{cd}	7.1^{ab}	38.5^{c}	6.9^{c}
4064	PT4.2216	Ekona 1	67.2^{a}	9.8^{ef}	82.4^{a}	9.1^{abc}	8.4^{bc}	71.6^{bcd}	46.5^{abc}	25.8^{abc}	5.5^{c}	47.1^{ab}	8.5^{ab}
4044	PT4.1095	Ekona 1	64.9^{ab}	10.5^{abcdef}	83.9^{a}	8.6^{bc}	7.5^{c}	71.2^{bcd}	45.7^{abc}	24.8^{abc}	4.8^{c}	49.8^{ab}	9.0^{ab}
4063	PT4.2216	AVROS 1	65.8^{a}	12.1^{a}	77.5^{d}	10.1^{ab}	12.5^{a}	73.6^{abc}	46.3^{abc}	23.5^{cd}	8.0^{a}	36.6^{c}	6.6^{c}
4043	PT4.364	Ekona 1	68.6^{a}	10.7^{abcdef}	81.2^{abc}	9.6^{abc}	9.2^{b}	72.3^{abcd}	48.1^{ab}	26.8a	6.0^{bc}	49.7^{ab}	9.0^{ab}
4019	PT4.1793	Ekona 2	66.5^{a}	9.0^{f}	81.4^{abc}	10.5^{a}	8.1^{bc}	72.6^{abcd}	46.7^{abc}	25.2^{abc}	5.2^{c}	49.1^{ab}	8.8^{ab}
4052	PT4.373	Ekona 1	68.6^{a}	10.3^{bcdef}	83.9^{a}	8.5^{bc}	7.6^{bc}	71.1^{cd}	46.4^{abc}	26.6^{a}	5.1^{c}	51.5^{ab}	9.3^{ab}
4013	PT4.1109	Ekona 1	65.4^{a}	10.7^{abcdef}	82.9^{a}	9.1^{abc}	8.1^{bc}	72.4^{abcd}	47.7^{abc}	25.9^{abc}	4.9^{c}	51.1^{ab}	9.2^{ab}
4058	PT4.374	Ekona 1	65.6^{a}	9.6^{ef}	83.1^{a}	9.0^{abc}	7.9^{bc}	71.5^{bcd}	45.8^{abc}	25.1^{abc}	5.1^{c}	53.2^{a}	9.6^{a}
4072	PT4.1810	Ekona 1	66.6^{a}	10.3^{bcdef}	81.6^{ab}	10.1^{ab}	8.4^{bc}	69.8^{d}	44.9^{bc}	24.5^{abcd}	5.3^{c}	48.8^{ab}	8.8^{ab}
4062	PT4.373	AVROS 1	64.4^{ab}	12.0^{ab}	79.3^{bcd}	9.7^{abc}	11.0^{a}	72.2^{abcd}	46.1^{abc}	23.5^{cd}	6.9^{ab}	39.5^{c}	7.1^{c}
4053	PT4.373	AVROS 1	60.7^{b}	11.6^{abc}	78.9^{bcd}	9.6^{abc}	11.5^{a}	74.8^{a}	46.6^{abc}	22.3^{d}	6.9^{ab}	39.8^{c}	7.2^{c}
4048	PT4.2217	Ekona 1	67.3^{a}	9.9^{def}	83.9^{a}	8.6^{bc}	7.5^{c}	72.7^{abcd}	46.6^{abc}	26.4^{ab}	4.9^{c}	53.7^{a}	9.7^{a}
4049	PT4.1095	AVROS 1	65.3^{a}	11.7^{abc}	79.2^{bcd}	9.0^{abc}	11.8^{a}	74.2^{abc}	47.7^{abc}	24.6^{abcd}	7.5^{a}	44.3^{bc}	8.0^{bc}
4045	PT4.364	AVROS 1	65.8^{a}	11.5^{abcd}	78.5^{cd}	9.6^{abc}	11.9^{a}	74.4^{ab}	46.3^{abc}	23.8^{bcd}	7.8^{a}	37.2c	7.0^{c}

Mean		66.1	10.6	81.3	9.5	9.3	72.5	46.4	24.9	5.9	46.8	8.4
CV%		8.4	20.9	5.0	22.9	27.8	5.2	8.2	12.6	30.2	23.5	23.4
F value		1.7^{ns}	3.1**	5.0**	1.6^{ns}	11.7**	1.6^{ns}	1.1^{ns}	2.4^{ns}	8.1**	5.5**	5.5**
D x P Control	DS116/2667 x 0.835/85	64.7^{a}	9.8^{b}	82.8^{a}	8.1^{c}	9.1^{b}	72.8^{a}	48.6^{a}	26.0^{a}	5.6^{b}	50.4^{a}	9.1^{a}

Means with the same letter are not significantly different
* - Significant at 5% level
** - Significant at 1% level
NS - Not significant

Table 6 : Bunch Components Comparison Between Semiclonal DXP of Ekona and AVROS Pisifera Progenies

		Mean Squares										
Item	**df**	**F/B%**	**MFW**	**M/F%**	**S/F%**	**K/F%**	**O/DM%**	**0/WM%**	**O/B%**	**K/B%**	**O/P (KG)**	**O/Ha (m/ton)**
Block	4	7.4^{ns}	3.6^{ns}	14.7^{ns}	4.4^{ns}	6.6^{ns}	40.0^{ns}	22.3^{ns}	5.9^{ns}	1.7^{ns}	38.3^{ns}	1.2^{ns}
CD484 X P	1	291.2^{ns}	133.2**	740.6**	2.1^{ns}	669.1**	202.8**	10.8^{ns}	184.7**	242.5**	6423.0**	207.9**
Error	286	29.8	4.3	13.8	4.7	4.1	13.5	14.5	9.2	2.3	98.0	3.2
CD484 X Ekona		66.8^{a}	10.0^{b}	82.6^{a}	9.3^{a}	8.1^{b}	71.9^{b}	46.4^{a}	25.6^{a}	5.2^{b}	50.5^{a}	9.1^{a}
CD484 X AVROS		64.7^{b}	11.4^{a}	79.3^{b}	9.5^{a}	11.3^{a}	73.6^{a}	46.8^{a}	23.9^{b}	7.1^{a}	40.8^{b}	7.4^{b}
Mean		66.0	10.5	81.4	9.4	9.3	72.5	46.5	25	5.9	46.9	8.4
CV (%)		8.3	20.7	5.0	23.1	27.4	5.3	8.2	12.5	30.0	23.2	23.2
F value		9.8^{ns}	30.8**	53.7**	0.5^{ns}	161.7**	15.1**	0.8^{ns}	20.0**	103.9**	65.5**	65.5**
D x P Control		64.7	9.8	82.8	8.1	9.1	72.8	48.6	26.0	5.6	50.4	9.1

Means with the same letter are not significantly different
* - Significant at 5% level
** - Significant at 1% level
NS - Not significant