J. Trop. Agric. and Fd. Sc. 31(2)(2003): 165–170

Yield performance and selection of F_1 hybrid Liberica coffee

(Prestasi hasil dan pemilihan baka kacukan F_1 kopi Liberica)

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Key words: Coffee, *Coffea liberica*, F_1 hybrid, hybridization, breeding

Abstrak

Dalam penilaian terhadap 1 350 baka kacukan F_1 kopi jenis Liberica, 20 pokok individu dengan indeks hasil antara 3.04–5.74 telah dikenal pasti dan dipilih. Kesemuanya menghasilkan berat 100 kopi jambu dan kopi beras yang lebih tinggi daripada klon piawaian semasa. Berat 100 kopi jambu dan kopi beras masing-masing ialah 550.6–932.3 g dan 30.08–39.91 g dengan lebih kurang 0.75–70.59% dan 6.10–40.78% lebih berat. Berat bagi klon piawaian semasa ialah 546.5 g dan 28.35 g. Kriteria dan asas pemilihan turut dibincangkan. Baka-baka terpilih yang berpotensi ini telah dibiakkan secara tampang dan dipelihara dalam kawasan germplasma di MARDI Kluang, Johor untuk penilaian klon pada masa hadapan.

Abstract

In an evaluation of 1 350 F_1 hybrid progenies of Liberica coffee, 20 individual plants with yield indices between 3.04–5.74 have been identified and selected. All of them showed higher 100-fresh berry and green bean weights as compared to the current clonal standards. Their respective 100-fresh berry and green bean weights of 550.6–932.3 g and 30.08–39.91 g were about 0.75–70.59% and 6.10–40.78% heavier. The respective weights of the current clonal standards were 546.5 g and 28.35 g. The criteria and basis of selection were also discussed. These selected potential progenies have been multiplied vegetatively and maintained in the germplasm area at MARDI Kluang, Johor awaiting for future clonal evaluation.

Introduction

Liberica type coffee (*Coffea liberica* Bull Hiern) is a hardy perennial crop grown commercially over a wide range of soil types in Malaysia. It is planted as a monocrop or intercropped with coconut and fruit trees mostly by smallholders. The green beans are usually roasted, powdered and marketed mostly within the country as different brands of coffee mixtures. Factors such as higher yield production, better local price, ease of maintenance and low pest infestation probably contribute to the preference by local coffee growers such as in Johor and Selangor to grow this species as compared to Robusta type coffee (*Coffea canephora* Pierre ex Froehner). Nevertheless, both species are suitable to be cultivated in the lowland areas of the warm tropical climate of this country.

The genetic base of Liberica coffee in this country could be considered narrow.

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However, due to its self-sterile nature (Carvalho et al. 1969), variations in yield, berry and bean sizes, and other related characters among both single plants (Muhamad Ghawas and Miswan 1985) and progenies (Muhamad Ghawas and Wan Rubiah 1988, 1991) were found to be significant. The breeding strategies and selection programme (short, medium and long term) for the development of better planting materials of coffee have been presented earlier (Muhamad Ghawas 1986). Apart from evaluation of planting materials sourced from single plant selections of open-pollinated progenies, controlled hybridizations between selected parents with certain traits could ensure the availability of new desirable recombinants for selection.

The request for better planting materials by the Ministry of Agriculture (Anon. 1985) has been partially fulfilled by MARDI through the release of polyhybrid planting materials (MKL 1) in 1992 (Razak Rashid 1992; Zulkifli 1992) and three clones (MKL 2, MKL 3 and MKL 4) in 1995 (Anon. 1995a; 1995b). In a working paper on action plans for food production (Anon. 2000), it was stated that the government should still continue to give support to ensure that the local coffee industry in the country is sustainable.

The main objective of this evaluation was to identify and select, among the evaluated F_1 hybrid progenies, superior individual plants with high yield and certain standards for physical berry and bean qualities for future clonal trials. This article reports on the performance and selection of these materials.

Materials and methods

Based on the Liberica coffee germplasm available in 1990, a total of 14 clones were selected for controlled hybridizations. These clones have certain desirable characters for yield production such as boldness of berries and beans, high conversion factors from berry to bean, compactness of berries/node and short internodes of lateral branches. For ease of accessibility for hybridization work and security in harvesting of the hybrid berries, the selected parental materials were vegetatively propagated (3 plants/clone), grown in containers and allowed to flower in an insect-proof house at MARDI Station Kluang, Johor.

To ensure possibility of selfing, emasculation of stamens from each flower due for hybridization process was carried out. Flowers were emasculated a day before anthesis i.e. during the 'candle-stage' by slight insertion of a razor blade at the base of the corolla tube of the individual flower. The flower was then slightly twisted and the corolla with the attached stamens were lifted leaving behind the pistil. The flowers were then wrapped in tightly woven cotton sleeves supported by a wire-mesh frame. Pollination using a fine brush was done the following day. The flowers were tagged according to the crosses made. The pollinated flowers were re-wrapped for a week before removal of the cotton sleeves to allow the berry to develop naturally. The number of crosses among the parental materials varied, depending on the availability of flowers during any one time.

The ripe berries were harvested about 11–12 months after pollination. Germination and maintenance of seedlings in polybags were done in the nursery. Seedlings at the 6–7 leaf-stage were field planted in mid 1992 at MARDI Kluang, Johor. The area is about 100 m above sea level and has a mean annual rainfall of about 2 300 mm with no regular drought (Nieuwolt 1992). Plants were grown in the open under rainfed conditions. The planting distance and maintenance were carried out according to the standard recommended practices for Liberica coffee (Yau and Abd. Rahman Azmil 1991).

First flowering of these progeny seedlings begins at about 12 months after field planting while first harvesting of ripe berries were obtained about 23–27 months of plant growth. Full bearing and yield begin to stabilize after the fourth or fifth year. The

yields of individual plants were harvested and recorded from the first to fourth year of production. Samples of ripe berries from individuals with potential were collected for three seasons to determine the average of berry and green bean sizes. The conversion factor (% of green bean from berries) was obtained through processing of fresh berries to green beans (to about 12.5% moisture). While the green bean yield was obtained through calculation using the conversion percentage of the respective individual plant as a factor.

Yield index and sizes of berries and beans were used as the basis of identification and selection. Yield index of an individual plant is the relative production as compared to the mean of the same age population where the individual plant is grown. Fresh berry yields, which were more than three times as compared to the average yield of the F_1 hybrid progenies evaluated, were used as the main criterion of selection. For future objectives of improvement in the physical characters of berry and bean sizes, the average weights of the current recommended clones (MKL 2, MKL 3 and MKL 4) were used as current clonal standards (CCS) for cross comparison. These clones were evaluated previously in the same location and environment. Selected individuals should also show equivalent or heavier weights as compared to the CCS. Selected individual plants were vegetatively propagated and planted in the germplasm area awaiting future clonal evaluation.

Results and discussion

A total of 1 350 F_1 progenies were obtained from the 165 random cross combination between selected parental materials. The number of progenies obtained from each cross combination varies from 4 to 46 progenies. The high variation in the numbers of progenies obtained was mainly due to the unavailability of flowers at the same time for crossing purposes. First harvesting of ripe berries among the F_1 progenies was carried out at the end of the second year of field planting. The cumulative fresh berry and green bean yields over the first four years of production were 61.3–115.8 kg and 5.07–9.88 kg respectively. Their respective means were 70.6 kg and 6.80 kg *(Table 1)*. Positive correlation coefficients of 0.84 to 0.98 between early yields and cumulative yields over 5 to 8 years among polycrossed progenies (Muhamad Ghawas 1991) and clonal materials (Muhamad Ghawas 1994) of Liberica coffee have been established earlier.

According to Carvalho et al. (1969), the relative productivity should be stressed more than absolute production in a coffee selection programme. Individual plants showing a yield index of three times or more as compared to the plot mean yield where they were evaluated is considered a fair criterion for selection. In this evaluation, 20 progenies or 1.5% of the population showed yield indices between 3.04 and 5.74. They were identified and selected.

Berry and bean sizes were also used as bases for selection. Apart from showing yield index greater than three times, selected individuals should also show equivalent or higher weights as cross compared to the average weights of the current recommended clones, MKL 2, MKL 3 and MKL 4 (Muhamad Ghawas 1994, 1995; Muhamad Ghawas and Mohamed 1995). This was to further improve the physical characteristic of berries and beans for future clonal evaluation.

The 100-fresh berry weights of the 20 selected cross progenies ranged from 550.6–932.3 g with a mean of 660.5 g *(Table 2)*. Progeny C 247 gave the smallest berry while C 300 was the biggest. These progenies were about 0.75–70.59% heavier as compared to the average weight of the CCS. Bold and bigger berries apart from giving better physical qualities, could also facilitate in ease of harvesting. This probably could reduce the time taken during harvesting.

Likewise, the 100-green bean weights of all the progenies were bigger than the

Table 1. Cumulative fresh berry and green bean yields over the first four years and yield indices of 20 selected crossed progenies of Liberica coffee

Prog. No.	Crosses	Yield (kg/plant)		Yield Index
		Berry	Bean	
C 046	MCL 112 x MCL 108	67.6	8.08	3.35
C 083	MCL 112 x MCL 171	76.1	6.35	3.78
C 084	MCL 112 x MCL 171	66.2	5.81	3.28
C 097	MCL 112 x MCL 171	61.3	5.74	3.04
C 099	MCL 112 x MCL 171	68.8	6.89	3.41
C 247	MCL 145 x MCL 171	71.0	8.04	3.52
C 250	MCL 034 x MCL 076	66.9	6.72	3.32
C 255	MCL 034 x MCL 169	79.0	7.24	3.92
C 299	MCL 171 x MCL 099	66.9	5.79	3.32
C 300	MCL 171 x MCL 099	75.0	5.09	3.75
C 309	MCL 171 x MCL 169	62.3	7.07	3.09
C 348	MCL 067 x MCL 071	76.5	8.98	3.79
C 469	MCL 165 x MCL 108	62.2	6.81	3.09
C 774	MCL 046 x MCL 169	65.1	6.01	3.23
C 843	MCL 099 x MCL 171	61.8	6.34	3.07
C 844	MCL 099 x MCL 171	61.8	5.97	3.07
C 904	MCL 112 x MCL 099	77.8	8.47	3.86
C 924	MCL 112 x MCL 169	115.8	9.88	5.74
C 1035	MCL 099 x MCL 169	67.5	5.57	3.35
C 1039	MCL 099 x MCL 169	61.9	5.07	3.07
Mean		70.6	6.80	3.50

CCS (28.35 g). They ranged from 30.08 g to 39.91 g. The increment obtained were between 6.10% and 40.78%. Progeny C 083 gave the smallest green bean while C 904 was the heaviest. Bigger green bean sizes could give better physical quality.

The conversion percentages of the 20 selected progenies were between 6.73% and 11.95% with a mean of 9.67%. Twelve of them (C 046, C 099, C 247, C 250, C 255, C 309, C 348, C 469, C 774, C 843, C 844 and C 904) with a range of 9.16 to 11.9 g were about equivalent or bigger (9.12%) than the CCS. Higher conversion percentage could give better recovery rate of green bean production in primary processing of fresh berries.

For the purposes of identification of these plants in the future, the selected individuals were designated as the MCL series. They were vegetatively propagated, planted and maintained in the germplasm area. These materials will be used in future clonal evaluation using current recommended clones as checks.

Conclusion

In this evaluation, with the objective of identifying and selecting superior planting materials for future clonal evaluation, 20 individual plants were selected. Their yield indices obtained between 3.04 to 5.74 were three times or more as required for fair criterion in the selection of coffee progenies. For the improvement of physical qualities of berry and bean, the selected individuals gave bigger sizes as compared to the current clonal standards. In future evaluation of these planting materials, as clonal trials, higher yield with better physical qualities could be expected for recommendation. Their planting could give higher productivity and thus partly fulfill the local

Table 2. Mean weight of 100 fresh berries and green beans, conversion percentages and assigned germplasm accession numbers of the 20 selected crossed progenies of Liberica coffee and current clonal standard (CSS)

Prog. No.	100-wt (g)		Conversion %	Germplasm Acc. No.
	Berry	Bean		
C 046	563.5	34.94	11.95	MCL 235
C 083	660.6	30.08	8.34	MCL 237
C 084	644.1	30.68	8.78	MCL 238
C 097	656.9	31.40	8.92	MCL 239
C 099	705.5	39.03	10.01	MCL 240
C 247	550.6	33.51	11.32	MCL 243
C 250	691.3	36.77	10.05	MCL 244
C 255	651.7	32.75	9.16	MCL 245
C 299	737.2	35.79	8.66	MCL 246
C 300	932.3	36.03	6.73	MCL 247
C 309	645.1	39.58	11.35	MCL 261
C 348	575.4	34.30	11.74	MCL 248
C 469	585.2	35.15	10.95	MCL 249
C 774	702.4	33.98	9.23	MCL 252
C 843	622.8	36.20	10.26	MCL 253
C 844	589.7	30.31	9.66	MCL 262
C 904	598.4	39.91	10.89	MCL 256
C 924	688.4	32.94	8.86	MCL 257
C 1035	753.9	34.31	8.25j	MCL 258
C 1039	655.1	33.21	8.19	MCL 263
Mean	660.5	34.54	9.67	
CCS*	546.5	28.35	9.12	

*Current recommended clones (MKL 2, MKL 3 and MKL 4)

raw materials requirements for processing into coffee products.

Acknowledgement

The author thanks research assistant, Ms Kamaliah Ayob of MARDI Station in Kluang, Johor for her invaluable assistance in the hybridization work, field maintenance, collection and compilation of data. He also thanks the other supporting staff, Mr Mohamed Kemat and Mr Mohd. Noh Yusof for their assistance. Thanks are also due to management of MARDI Station Kluang, Johor for the supports given. This project was funded by IRPA (Research Grant No. 01-03-03-0186).

References

Anon. (1985). MARDI diminta jalankan kajian benih kopi. *Utusan Malaysia* 17 April 1985, p. 3

—— (1995a). Klon baru ganda hasil kopi. *Harian Metro* 27 May 1995, p. 7

—— (1995b). Kopi Liberica meningkat. *Utusan Malaysia* 27 May 1995, p. 31

—— (2000). Pelan tindakan pengeluaran makanan: Tanaman Kopi. Kertas jawatankuasa perancangan dan dasar Kementerian Pertanian (JPDKP). Bahagian Perancangan Makro & Strategik, Kementerian Pertanian Malaysia. p. 16–26

Carvalho, A., Ferwerda, F.P., Frahm-Leliveld, J.A., Medina, A.J.T., and Monaco, L.C. (1969). Coffee. In: *Outlines of perennial crops breeding in the tropics* (Ferwerda, F.P. and Wit, F. ed.) p. 189–241. Misc. Papers 4. Landbouwhogeschool Wageningen: The Netherlands

Muhamad Ghawas, M. (1986). The breeding programmes of spices and beverage crops and their problems and constraints. *Proc. Workshop on plant and animal breeding* 7–9 Oct. 1986, Serdang (Ahmad Zamzam, M. and Tan, S.L., ed.) p. 211–28. Serdang: MARDI

—— (1991). Yield performance and selection of *Coffea liberica* progenitors. *MARDI Res J.* ***19(2):*** 177–82

—— (1994). Evaluation and selection of Liberica coffee clones. *MARDI Res. J.* ***22(2)***: 135–40

—— (1995). Improved planting materials. *Proc. Malaysian Science & Technology Congress* Vol. IV. 22–25 August 1995, Kuala Lumpur. p. 262-8. Kuala Lumpur: Science, Tech. and Environ. Ministry, Malaysia

Muhamad Ghawas, M. and Miswan, J. (1985). Preliminary selections of Liberica and Robusta type coffee. *Teknol. Pelbagai Tanaman, MARDI* ***1***: 37–41

Muhamad Ghawas, M. and Mohamed, K. (1995). Prestasi klon-klon kopi Liberica dan Robusta yang disyorkan. *Teknol. Pelbagai Tanaman, MARDI* ***11***: 1–11

Muhamad Ghawas, M. and Wan Rubiah, A. (1998). Variations in fruit and bean characters in seedling progenies of Robusta and Liberica type coffee. *MARDI Res. J.* ***16(2)***: 97–101

—— (1991). Yield performance and selection of *Coffea liberica* progenitors. *MARDI Res. J.* ***(19(2)***: 172–82

Nieuwolt, S. (1982). *Climate and agriculture planning in Peninsular Malaysia* (A Special Report) 108 p. Serdang: MARDI

Razak Rashid, G. (1992). MARDI berjaya keluarkan benih kopi bermutu tinggi. *Utusan Malaysia* 6 July 1992, p. 8

Yau, P.Y. and Abd. Rahman Azmil, I. (1991). Penanaman dan pengeluaran di ladang. In: *Pengeluaran Kopi.* (A special report) p. 19–30. Serdang: MARDI

Zulkifli, O. (1992). MARDI develops high yielding coffee strains. *New Straits Times* 7 July 1992, p. 8

Accepted for publication on 3 June 2003