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Yield performance of Liberica coffee clones on peat soil

(Prestasi penghasilan klon kopi Liberica di tanah gambut)

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Key words: *Coffea liberica,* peat soil, yield performance

Abstrak

Perbezaan yang ketara dari segi hasil dan parameter lain telah diperoleh daripada penilaian terhadap 10 klon kopi Liberica di tanah gambut. Tiga klon yang terbaik iaitu MCL 21, MCL 26 dan MCL 45 memberikan hasil purata biji kopi masing-masing 1.47, 1.82 dan 1.64 t/ha bersamaan hasil kopi jambu 16.3, 18.2 dan 20.1 t/ha. Hasil purata biji kopi sebanyak 1.64 t/ha kira-kira 66% lebih tinggi daripada hasil pokok bandingan (baka pendebungaan terbuka). Hasil purata ini 24% lebih rendah dibandingkan dengan hasil klon-klon yang sama di tanah mineral. Walau bagaimanapun, kopi jambu dan biji kopinya masing-masing 11.7% dan 3.3% lebih berat.

Abstract

Significant differences in yield and other parameters were obtained among 10 Liberica coffee clones evaluated on peat soil. Three top clones, namely MCL 21, MCL 26 and MCL 45, gave mean green bean yields of 1.47, 1.82 and 1.64 t/ha equivalent to fresh berry yields of 16.3, 18.2 and 20.1 t/ha respectively. Their mean green bean yield of 1.64 t/ha was about 66% higher than the yield of check plants (randomly selected open-pollinated seedlings). This value was, however, about 24% lower when cross-compared with the same set of clones on mineral soil while their respective fresh berry and green bean weights were about 11.7% and 3.3% heavier.

Introduction

Coffea liberica Bull ex Hiern (Liberica type coffee) was introduced into Malaysia during the 19th century (Bunting and Milsum 1930). Since then, this self-sterile and highly polymorphic coffee species (Ferwerda and Wit 1969) is grown commercially over a wide range of soil types including drained peat. This perennial crop can tolerate soil acidity of about pH 4 (Kanapathy 1975) and its tap root can grow to 0.5–4.0 m deep depending on the soil condition and type.

Malaysia has about 2.4 million hectares of peat soil. Only about 32% in Peninsular Malaysia and 3% in Sarawak have been used for agriculture (Mutalib et al. 1991). Although peat is considered a problem soil, Leong et al. (1989) considered coffee a potential crop on peat with necessary amendments such as water management, liming and supply of nutrients.

Information on the yield performance and potential of Liberica coffee on peat is limited. An observational trial on micronutrient requirements on shallow peat (< 1.0 m) in the early 1970s (Lim 1978) reported fresh berry yield of 5.5–14.1 t/ha. Another trial (Kueh and Wong 1991) on

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deep peat (>3.0 m) in Sarawak gave yields of only 1.1–2.5 t/ha. Yau and Abd. Rahman Azmil (1990) obtained a yield of 14.7 t/ha from the single stem system, commonly used by Liberica coffee growers, in a pruning study on shallow peat. In these evaluations, open-pollinated seedlings were used as planting materials.

The technique of vegetative propagation through nursery grafting of Liberica coffee is available (Muhamad Ghawas and Miswan 1984). Evaluation of the resultant coffee clones on peat would further verify their potential. This article reports on the yield performance and identification of 10 suitable clones on peat for recommendation.

Materials and methods

Ten clones, grafted on randomly selected seedlings, were evaluated. The clones were obtained from several locations locally (Muhamad Ghawas and Miswan 1985). Due to the lack of recommended planting materials at that time, randomly selected open-pollinated seedlings were used as the check plants. Eight-month-old planting materials were field planted in early 1988 on moderately deep peat (1.0–3.0 m) at the MARDI Research Station in Pontian, Johor. The soil acidity was between pH 3.6 and 4.0. The experiment site is about 3.0 m above sea level and has a mean annual rainfall of 2 200 mm which is well distributed throughout the year (Nieuwolt 1982).

The experimental design was randomized complete block with three replications. Each treatment plot consisted of eight plants, surrounded by a row of randomly selected open-pollinated guard plants. The planting distance was 3.0 m triangular giving a density of about 1 280 plants/ha. Plants were grown in the open under rainfed condition. They were maintained as single stems and topped at 1.7 m above the ground.

Basal fertilizers consisted of 200 g CIRP (Christmas Island Rock Phosphate), 200 g hydrated lime powder and 10 g $CuSO_4.5H_2O$ per planting hole. During the first year of growth, a compound fertilizer with a ratio of 18 N: 11 P_2O_5: 5 K_2O: 2.5 MgO was used. For the second and subsequent years, the compound 12 N: 12 P_2O_5: 17 K_2O: 2 MgO + TE was applied. The yearly amount of fertilizer application is shown in *Table 1*. Fertilizer and hydrated lime powder applications were split into four and two equal amounts respectively, while $CuSO_4$ was applied only once each year. According to Leong et al. (1989), a yearly application of 0.25–0.5 kg lime per planting point is commonly carried out for perennial crops like fruit trees and coffee on peat soil. Disease and pest management comprised about half-yearly applications of *Coprantol* at 0.1% a.i. for protection against leaf rust and endosulfan at 0.1% a.i. against berry borer.

The yields of individual plants were recorded from the first to the seventh year (1989 to 1995). Correlations of annual yields were studied to determine any association between earlier and subsequent years' production. Ripe berries were sampled from each treatment for four seasons (1991 to 1994) to determine berry and green bean sizes. The conversion percentages were obtained through processing fresh berries to green beans (at 12.5 ± 0.5% moisture). The green bean yield

Table 1. Yearly fertilizer application for Liberica coffee on peat soil

Year	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	MgO (kg/ha)	$CuSO_4.5H_2O$ (kg/ha)	Hydrated lime powder (kg/ha)
1	46	28	12	6	–	128
2	62	62	87	10	13	256
3	93	93	131	15	20	384
4 and above	154	154	218	26	26	512

was determined by computation. Analyses of variance and Duncan's Multiple Range Test (DMRT) on mean plot yield data (fourth to seventh year) and other parameters were carried out. Significant differences among the planting materials were used as the basis to select clones.

Results and discussion

About 75% of the treatment plants flowered after 7–8 months of field planting. First harvest of ripe berries commenced on the 18th month. Significant differences in yield were obtained among the treatments beginning from the first year's production *(Table 2).* Each treatment showed an increasing yield trend from the first to the third year. The clonal mean fresh berry yields in the 1st, 2nd and 3rd years were 0.17, 4.1 and 10.0 t/ha while the check plants gave corresponding yields of 0.02, 3.0 and 8.2 t/ha respectively. Production of all the treatments began to stabilize from the fourth year, i.e. after about 5 years of field growth. The yearly range for the 4th, 5th, 6th and 7th years was 9.0–19.9, 9.4–21.9, 12.1–21.8 and 9.6–18.8 t/ha respectively.

Analyses of fresh berries and green beans from the fourth to the seventh year of production showed significant differences in yield and other parameters monitored among the clones evaluated *(Table 3).* The mean fresh berry and green bean yields of the clones ranged from 10.3 to 20.1 t/ha and 0.72 to 1.82 t/ha respectively. The check plants showed a mean fresh berry yield of 10.7 t/ha with an equivalent green bean yield of 0.99 t/ha.

Four clones, namely MCL 16, MCL 21, MCL 26 and MCL 45, showed significantly higher green bean yields than the check. Their respective yields were 1.22, 1.47, 1.82 and 1.64 t/ha. Based primarily on green bean yield, fresh and green bean sizes, the top three clones, i.e. MCL 21, MCL 26 and MCL 45, were identified *(Plate 1).* Although MCL 21 had significantly lower mean green bean yield than MCL 26, it was included. This is due to the self-sterile nature of Liberica coffee whereby at least three clones have to be planted in an area for sufficient pollination.

Boldness of berry size facilitates harvesting, and uniformity in bean character is an important factor for even roasting during processing for quality coffee powder. Clone MCL 16 was therefore excluded because it had small berry and bean sizes.

Table 2. Yearly fresh berry production of 10 Liberica coffee clones and a check on peat soil

Clone No.	Yield (t/ha)						
	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year
MCL 16	0.33a	5.6ab	14.8a	15.6bc	14.4bcd	14.1cd	12.1bc
MCL 19	0.13bc	3.4bc	9.6abc	13.0cd	13.1cde	13.4cd	13.0b
MCL 21	0.17bc	4.0bc	10.9abc	15.7bc	16.1bc	17.3b	16.2a
MCL 24	0.05bc	1.7c	10.1abc	17.7ab	15.9bc	15.0c	12.2bc
MCL 26	0.13bc	6.0ab	13.5ab	18.2ab	16.8b	19.7a	18.2a
MCL 34	0.14bc	4.1bc	7.4bc	12.1cd	10.9de	12.8cd	11.3bc
MCL 40	0.34a	4.4bc	8.4abc	11.9cd	11.8de	13.0cd	11.6bc
MCL 42	0.14bc	1.3c	4.2c	9.7d	9.9e	12.1d	9.6c
MCL 45	0.21ab	7.4a	14.5a	19.9a	21.9a	21.8a	16.8a
MCL 64	0.07bc	3.1bc	6.6c	9.0d	11.0de	12.4d	10.3bc
Mean	0.17	4.1	10.0	14.3	15.6	15.2	13.1
Check	0.02c	3.0bc	8.2abc	9.9d	10.7e	12.3d	9.9bc
SE	0.09	1.6	3.5	1.9	1.3	1.3	1.6
LSD (5%)	0.15	2.8	5.9	3.9	3.3	2.3	2.7

Mean values in the same column with different letters are significantly different ($p < 0.05$) according to DMRT

Table 3. Mean (4th to 7th year) fresh berry and green bean yields, conversion percentages, weight of 100 fresh berries and green beans of 10 Liberica coffee clones and a check on peat soil

Clone No.	Fresh berry yield (t/ha)	Green bean yield (t/ha)	Conversion (%)	100-fresh berry wt. (g)	100-green berry wt. (g)
MCL 16	14.1cde	1.22c	8.67e	511.6d	23.71f
MCL 21	16.3bc	1.47b	9.02d	585.8bc	29.53b
MCL 26	18.2ab	1.82a	10.01a	556.3c	28.62c
MCL 45	20.1a	1.64ab	8.16f	718.5a	29.85b
MCL 24	15.2cd	1.04cd	6.85g	574.8bc	25.13e
MCL 19	13.1def	1.20cd	9.11cd	463.9ef	26.30d
MCL 40	12.1efg	1.05cd	8.57e	489.6de	23.38f
MCL 34	11.8efg	1.10cd	9.38b	589.6b	30.40a
MCL 64	10.7fg	0.72f	6.77g	709.5a	25.76d
MCL 42	10.3g	0.83ef	8.15f	433.4f	19.61g
Mean	14.2	1.21	8.47	563.3	26.23
Check	10.7fg	0.99de	9.31bc	461.1ef	25.99d
SE	11.3	0.12	0.14	17.7	0.31
LSD (5%)	2.2	0.20	0.24	30.2	0.53

Mean values in the same column with different letters are significantly different (p <0.05) according to DMRT

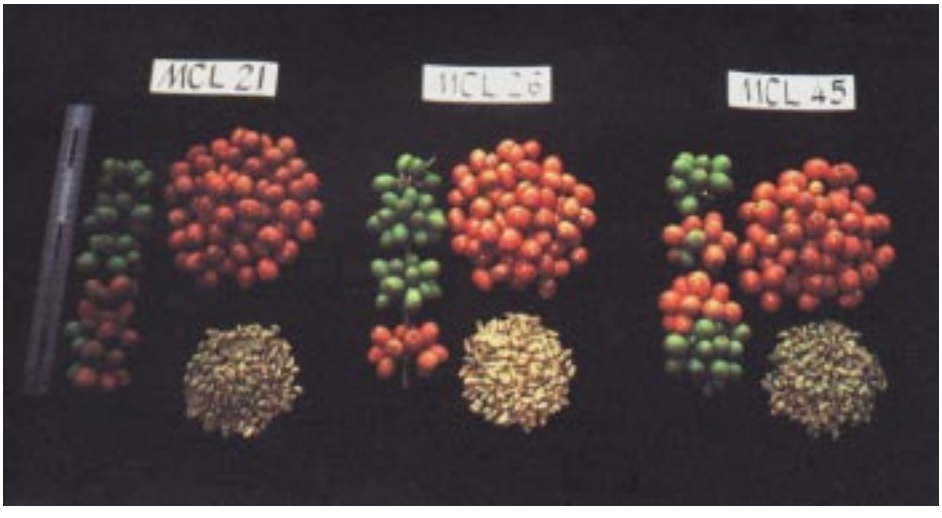

Plate 1. Fresh berries and green beans of three selected Liberica coffee clones on peat soil

The berry weights of the three clones were among the biggest, ranging from 556.3 to 718.5 g with a mean of 620.3 g. Their bean sizes apart from uniformity were also the largest ranging from 28.62 to 29.85 g (mean of 29.33 g). Their conversion percentages ranged from 8.16% to 10.01%.

The mean fresh berry and green bean yields of the three clones were 18.2 and 1.64 t/ha respectively. These yields were 70.1% and 65.7% respectively higher than the check while their mean berry and green bean sizes were 34.5% and 12.9% larger. When cross-compared with the same set of clones (MCL 21, MCL 26 and MCL 45) evaluated on mineral soil (Muhamad Ghawas 1994) and released (Anon. 1995; Sharif 1995) as MKL 2, MKL 3 and MKL 4

Table 4. Correlation coefficient among yearly yields and cumulative yields (over 7 years) of Liberica coffee clones on peat soil

Year	1	2	3	4	5	6	7	Cumulative yield
1	–	0.51ns	0.37ns	0.07ns	0.07ns	0.03ns	0.03ns	0.17ns
2	–	–	0.81**	0.61ns	0.69**	0.73*	0.70*	0.80**
3	–	–	–	0.87**	0.83**	0.76*	0.75*	0.91***
4	–	–	–	–	0.93***	0.88***	0.82***	0.95***
5	–	–	–	–	–	0.95***	0.84**	0.96***
6	–	–	–	–	–	–	0.93***	0.96***
7	–	–	–	–	–	–	–	0.91***

ns = not significantly different
*p <0.05, **p <0.01, ***p <0.001

respectively, their mean fresh berry and green bean yields were about 24.2% and 24.4% respectively lower. However, their respective mean berry and green bean weights were 11.7% and 3.3% heavier. The range of fresh berry weight of these clones on mineral soil was 501.7–621.2 g with a mean of 546.5 g, while the green bean weight was between 27.39 g and 29.61 g (mean of 28.55 g).

The correlation coefficient between the first year's yield and cumulative yield over 7 years was not significantly different *(Table 4).* However, beginning from the second year's production, i.e. 3 years after field planting, a positive correlation of 0.80 was obtained. The correlation coefficient increased to 0.91 and 0.95 on the third and fourth years. The same positive trends were also obtained from previous clonal (Muhamad Ghawas 1994) and progeny trials (Muhamad Ghawas and Wan Rubiah 1991) on mineral soil. This confirms the possibility of screening for yield potential in Liberica coffee from as early as the second year of production.

Besides identification of a few suitable clones, this evaluation showed the yield potential of Liberica coffee on peat may be increased through the use of better planting materials. It is hoped that with these findings, more unutilized peatland may be developed for Liberica coffee, while production may be enhanced to meet the demand for coffee by the increasing population of the country.

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