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Yield performance of Robusta coffee clones top-worked on Liberica coffee

(Prestasi penghasilan klon kopi Robusta melalui cantuman dewasa pada kopi Liberica)

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Key words: Robusta coffee, clones, yield evaluation, top-working, Liberica coffee

Abstrak

Penilaian terhadap 13 klon kopi Robusta melalui cantuman dewasa pada pokok kopi Liberica di Kluang, Johor menunjukkan perbezaan yang ketara bagi hasil serta parameter lain yang dikaji. Di samping penghasilan awal, tiga klon yang terbaik (MCR 28, MCR 29 dan MCR 36) berpotensi memberikan hasil biji kopi masing-masing 1.78, 1.59 dan 1.66 t/ha bersamaan hasil kopi jambu sebanyak 8.11, 7.60 dan 7.08 t/ha. Pekali kepembolehubahan hasil bagi ketiga-tiga klon yang dikenal pasti paling rendah (15.1–20.4%) berbanding dengan purata keseluruhan klon (25.3%) dan perlakuan bandingan (43.8%).

Abstract

An evaluation of 13 Robusta coffee clones top-worked on Liberica coffee at Kluang, Johor showed significant differences in yield and other monitored parameters. Besides being early bearing, the three top yielders (MCR 28, MCR 29 and MCR 36) gave potential mean green bean yields of 1.78, 1.59 and 1.66 t/ha respectively, equivalent to fresh berry yields of 8.11, 7.60 and 7.08 t/ha. The coefficients of variation for yield of the three identified clones were among the lowest (15.1–20.4%) as compared with the overall mean of the clones (25.3%) and the check plants (43.8%).

Introduction

Coffee was introduced into Malaysia during the 19th century. The two species suitable for cultivation under conditions of warm tropical climate are Liberica (*Coffea liberica* ex Bull Hiern) and Robusta (*Coffea canephora* Pierre ex Froehner). Their economic life span is about 25–30 years. The country's production of green beans is about 4 000 t of Robusta coffee and 4 700 t of Liberica coffee (Anon. 1993). With the growing population, local consumption is expected to increase by about 2.5% annually. To meet the domestic requirement of Robusta coffee, estimated at 7 000 t annually, more than RM40 million has to be spent on imports (Wells 1993).

Techniques for rehabilitation or top-working through matured grafting of coffee plants and their advantages over replanting have been reported earlier (Muhamad Ghawas and Wan Rubiah 1986; Muhamad Ghawas 1993). Considering the need to boost local production of Robusta coffee and to reduce the import of coffee, an evaluation on the rehabilitation of mature Liberica

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coffee plants by top-working with various clones of Robusta coffee was conducted. The objectives were to study the yield performance as well as to identify suitable high-yielding and quality Robusta coffee clones for local coffee growers.

Materials and methods

Thirteen Robusta coffee clones grafted on 6-year-old randomly selected Liberica coffee plants were used in the evaluation. Field grafting and planting of check plants (seven to eight-leaf stage) were done in mid-1984 at MARDI research station, Kluang, Johor. The experimental site is about 100 m above sea level and has a mean annual rainfall of about 2 300 mm with no regular dry season (Nieuwolt 1982). Random open-pollinated seedlings were used as check plants due to unavailability of recommended clones as well as to confirm the soil and climatic suitability for Robusta coffee at the site of evaluation. Open-pollinated seedlings were the commercial planting materials at that time.

The experimental design used was randomized complete block design with three replications. Each treatment plot comprised a row of eight plants. The planting distance was 2.50 m x 2.75 m giving a density of 1 454 plants/ha. Top-working using the wedge method was done on watershoots of Liberica coffee plant at a height of about 10–15 cm. Watershoots (orthotrophic) of the Robusta coffee clones were used as scions. Pollarding or stumping of the Liberica plant to a height of about 15–20 cm was done about 6 months after grafting. Subsequent growth of watershoots from the remaining Liberica stem was removed regularly at 2 to 3-month intervals. This was to avoid competition in growth between the grafted Robusta clones and the Liberica rootstocks. The Robusta clones were trained to produce multiple-stems (2–4 stems/plant). No topping was done throughout the evaluation period. A new shoot at about 20–30 cm from the ground level was allowed to grow from each stem after about 4–5 years of plant growth. This was for continuous yield production as most of the lower primary branches would have naturally dropped by then. Petai (*Parkia* spp.), planted at a ratio of eight coffee plants to one petai plant, was used as shade tree. The plants were grown under rainfed conditions throughout the evaluation period.

Fertilizer application for the Robusta clones during the first year of growth comprised 400 g of compound fertilizer (18:7:12:2) per plant. In the 2nd, 3rd and subsequent years, compound fertilizer 12:12:17:2:Te was applied at 600 and 800 g/plant respectively. The fertilizer was broadcast around the coffee plant in a band between 0.3 m from the stem and the edge of the plant canopy. Test plants received higher rates of fertilizer than the check plants during the earlier growth. This was to sustain the growth of matured plants. For the check plants, the recommended rates for new planting (Yau and Rahman 1991) were applied. They comprised 250 g of fertilizer 18:17:12:2 per plant for the first year. In the 2nd, 3rd, 4th and subsequent years of growth, the fertilizer (12:12:17:2:Te) rate was 400, 600 and 800 g/plant respectively. All the fertilizer was split into four equal applications per year. Application of endosulfan or gamma BHC at 0.1% a.i. for protection against the berry borer beetle *(Hypoyhenemus hampei)* and fenthion (0.1% a.i.) against stem/twig borer (*Xylosandrus compactus* Eichh) as recommended (Mohd. Anuar and Loh 1991) was done at 2 to 3-month intervals.

Yield of individual plants was recorded over the first 6 years of production. Correlations among annual yields were studied to determine any association between the earlier with subsequent years' production. Variations within treatment were ascertained by calculating the coefficient of variation. Ripe berries were sampled from each treatment over four seasons (from the second to the fifth season) to determine berry and green bean sizes. The conversion percentages were obtained through

processing of berries (sundried for 10–12 days) to green beans (12.5 ± 0.50% moisture). The green bean yields were calculated. Analyses of variance and Duncan Multiple Range Test were carried out on mean plot yield data and the other parameters evaluated.

Results and discussion

The success of top-working of the 13 Robusta coffee clones ranged from 87.5% to 100.0% with an average of 95.8%. An average time of about 6 min/plant was taken for preparing the stock plants (removal of lower branches, etc.) and top-working. This was about the same length of time taken for preparing a hole, application of basal fertilizers and planting of seedling plant. Other operational costs such as removal of watershoots and training of scion canopy were common to both top-working and planting of seedlings.

First harvest of ripe berries for most of the clones commenced about 18 months after grafting. The first green bean yield of the check plants was not significantly different from yields of most of the clones except for MCR 28 and MCR 29 which gave higher yields of 0.40 and 0.47 t/ha respectively *(Table 1)*. However, when considering the propagation and growth stage of the seedlings in the nursery, about 10 months were saved.

Each treatment showed an increasing yield trend in the first and second year yields and began to stabilize from the third year of production, i.e. after the fourth year of plant growth. Significant differences in annual yields among them were obtained throughout the evaluation period.

Analyses of mean yields of fresh berries and green beans from the second to the sixth year of production showed that there were significant differences in yields and other parameters monitored *(Table 2)*. The mean fresh berry and green bean yields of the clones ranged from 4.39 to 8.79 t/ha and from 0.81 to 1.78 t/ha respectively. The check plants gave a mean fresh berry yield of 4.62 t/ha or an equivalent green bean yield of 0.90 t/ha. The conversion ranged from 11.4% to 23.4% while the weight of 100 fresh berries and green beans were 88.7–159.7 g and 8.2–15.9 g respectively.

Based on the green bean yield, five clones yielded significantly higher than the check plants. They were MCR 25, MCR 28, MCR 29, MCR 36 and BP 409. Among

Table 1. Green bean yields of 13 Robusta coffee clones with a check over 6 years

Clone no.	Yield (t/ha)					
	1st year	2nd year	3rd year	4th year	5th year	6th year
MCR 12	0.01c	0.82abc	1.46bc	1.53ab	1.03cde	1.24b–e
MCR 18	0.02c	0.57bc	1.32bcd	0.89cde	0.61e	1.52bcd
MCR 25	0.14abc	0.68bc	1.17cd	0.96cde	2.09ab	1.76bc
MCR 28	0.40ab	1.05ab	2.19a	1.39abc	1.37cd	2.91a
MCR 29	0.47a	1.34a	1.44bc	1.76a	1.51bc	1.90ab
MCR 30	0.06bc	0.49bc	1.15cd	0.68de	1.12cde	1.49bcd
MCR 31	0.05bc	0.82abc	1.27cd	1.13bcd	0.82de	0.59e
MCR 32	0.27abc	0.52bc	1.46bc	1.16bcd	1.25cde	1.16b–e
MCR 33	0.28abc	0.60bc	0.86cd	1.18bcd	0.82de	1.21b–e
MCR 35	0.20abc	0.73bc	0.69cd	0.58e	0.80de	1.26b–e
MCR 36	0.08bc	1.01ab	2.05ab	1.76a	2.27a	1.21b–e
MCR 37	0.00c	0.38c	0.65d	1.67ab	1.50bc	0.81de
BP 409	0.00c	0.78abc	1.36bcd	1.13bcd	1.41cd	1.73bc
Check	0.02c	0.56bc	1.07cd	0.73de	1.05cde	1.09cde

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

Table 2. Various mean (2nd to 6th year) yields of 13 Robusta coffee clones (top-worked on Liberica coffee plants) and a check

Clone no.	Fresh berry yield (t/ha)	Green bean yield (t/ha)	Yield C.V. (%)	Conversion (%)	100-fresh berry wt. (g)	100-green bean wt. (g)
MCR 12	5.92bcd	1.21cde	30.49	20.51de	133.6b	13.72c
MCR 18	5.94bcd	0.98def	13.29	16.53h	88.7g	8.21i
MCR 25	7.90a	1.33bc	17.98	16.86h	106.9de	9.35h
MCR 28	8.11a	1.78a	20.40	22.00b	104.4de	12.36d
MCR 29	7.60a	1.59ab	17.74	20.91cd	118.7c	12.63cd
MCR 30	5.41cd	0.99def	38.15	18.23g	99.4ef	10.78f
MCR 31	4.39d	0.93ef	31.87	21.09cd	91.1fg	10.23g
MCR 32	5.56cd	1.11c–f	39.86	20.01ef	111.9cd	10.54fg
MCR 33	5.50cd	0.93ef	29.15	16.96h	108.3de	9.17h
MCR 35	4.82d	0.81f	21.47	16.86h	121.6c	10.17g
MCR 36	7.08abc	1.66a	15.12	23.44a	121.6c	14.93b
MCR 37	8.79a	1.00c–f	33.39	11.39i	159.7a	13.47c
BP 409	6.09bcd	1.28bcd	19.67	21.31c	140.6b	15.89a
Check	4.62d	0.90ef	43.76	19.44f	113.4cd	11.56e

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

these, three clones (MCR 28, MCR 29 and MCR 36) were the top yielders, having yields not significantly different from one another. Their respective green bean yields were 1.78, 1.59 and 1.66 t/ha while their 100-green bean weights were 12.36, 12.63 and 14.93 g. The mean green bean yield of these clones (1.68 t/ha) was about 86.3% higher than the check plants (0.90 t/ha).

Besides high yield, the three clones were early bearers *(Table 1)*. The mean of the first two years' production (0.73 t/ha) was about 150% higher than the check (0.29 t/ha) and 120% higher than the mean of the rest of the clones evaluated. This character of earliness in production may help generate early income.

The coefficients of variation for yield of the top three clones were amongst the lowest (15.1–20.4%), while the coefficients of variations for the overall mean of the clones was 25.3% and the check gave 43.8%. When cross-compared with the overall mean of Robusta clones grafted on random open-pollinated seedling stock (25.8%) and random open-pollinated seedlings (43.8%) as check plant in Kedah (Muhamad Ghawas 1994), their coefficients of variation were comparable. Besides that, the green bean yields of the top yielders (in this case, MCR 28, MCR 29 and BP 409) which ranged from 1.53 to 1.71 t/ha, were not much different from the three identified clones in this evaluation. This may indicate that during the evaluation period, there was very minimal interaction between top-worked Robusta coffee clones and the Liberica coffee stocks in yield production. No clear physical incompatibility between stock and scion was observed.

The annual yield production of the clones evaluated was positively correlated to the 6-year cumulative yield *(Table 3)*. The correlation coefficients between the first and second year yield, and cumulative yield over 6 years were both 0.38. From the third year production onwards, the correlation value increased, ranging from 0.55 to 0.74. The same trend had been observed in the evaluation at Kedah (Muhamad Ghawas 1994). However, in that instance, highly positive correlations were obtained beginning from the second year production, with values ranging from 0.63 to 0.84.

Apart from having information on the possibility of top-working Robusta coffee clones on matured Liberica coffee plants, this study also shows that Robusta clones

Table 3. Correlation coefficient among annual yields and cumulative yields over 6 years of Robusta coffee clones top-worked on Liberica coffee plants

Year	1	2	3	4	5	6	Cumulative yield of 6 years
1	–	0.38*	0.17ns	0.12ns	0.02ns	0.28ns	0.38*
2	–	–	0.16ns	0.05ns	0.05ns	0.05ns	0.38*
3			–	0.12ns	0.16ns	0.41***	0.59***
4				–	0.54***	0.04ns	0.66***
5					–	0.18ns	0.74***
6						–	0.55***

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

MCR 28, MCR 29 and MCR 36 are most promising for this purpose. With these new findings, production of Robusta coffee in this country could be further enhanced through rehabilitation of existing Liberica coffee plants using suitable Robusta clones should the need arise.

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References

Anon. (1993). Tinjauan pasaran kopi, FAMA Oktober 1993 (mimeo.)

Mohd. Anuar, A. and Loh, C. F. (1991). Pengawalan serangga perosak dan penyakit. In *Pengeluaran kopi* (a special report) p. 31–9. Serdang: MARDI

Muhamad Ghawas, M. (1993). Pokok tua kahwin muda. *Berita Penyelidikan MARDI* ***31:*** 13

—— (1994). Yield performance and selection of Robusta coffee clones at Gajah Mati, Kedah. *MARDI Res. J.* ***22(2):*** 141–7

Muhamad Ghawas, M. and Wan Rubiah, A. (1986). Penilaian kaedah cantuman untuk pembaikpulihan tanaman kopi. *Teknol. Pelbagai Tanaman, MARDI* ***2:*** 43–51

Nieuwolt, S. (1982). *Climate and agricultural planning in Peninsular Malaysia* (a special report) p. 108. Serdang: MARDI

Wells, R. J. G. (1993). International coffee and tea outlook for 1993. *World Coffee and Tea J. (January):* 9

Yau, P. Y. and Abd. Rahman Azmil, I. (1991). Penanaman dan penyelenggaraan di ladang. 19–30. *See* Mohd Anuar and Loh (1991)

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