

Yields of 16 Arabica-type Coffee Varieties Grown Under Partial Shade and in Full Sunlight¹

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INTRODUCTION

Coffee is one of the main cash crops of the mountainous part of west central Puerto Rico. Recent statistics indicate that the area devoted to coffee here is estimated to be around 160,000 "cuerdas".³ The average yield in the area is less than 200 pounds of market coffee per cuerda. This yield is much lower than those obtained in other coffee-producing countries, or on a few intensively-managed sun-grown coffee groves in Puerto Rico. It has been claimed that most of the coffee grown in the area is improperly cultivated; under excessive shade, improperly fertilized, and poorly managed. The result is a production of only about 25 pounds of market coffee per cuerda.

In 1924, McClelland (2) described the coffee variety Puerto Rico pointing out its popularity and superior grades, which make it rank among the best of the coffees produced anywhere in the world. He described the Arabica, Liberica and robustoid groups. Vicente-Chandler et al. (3) described the varieties Puerto Rico, Caturra, Villalobos, Bourbon, and Mundo Nuevo, and pointed out their agronomic advantages. Wellman (5) indicated that the Bourbon variety produces 30 to 80 percent more than the Puerto Rico.

Abruña et al. (1) and Vicente et al. (4) carried out studies to determine the yields and quality of coffee produced by nine Arabica varieties grown under intensive management both in full sunlight and beneath shade trees at three locations in Puerto Rico. Yields were taken for 3 consecutive years starting 4 years after planting. During the last year, at the height of the picking season at the Jayuya experimental site, a sample of coffee berries was processed from each variety. Weight of market coffee per almud⁴ was determined. The beans were graded according to commercial standards. All nine varieties yielded more when grown under full sunlight than under

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³ A cuerda is equivalent to 0.9712 of an acre.

⁴ Unit used for measuring coffee in Puerto Rico, equivalent to 20 liters or 28 pounds of berries.

partial shade. The Mundo Nuevo and Puerto Rico 401 varieties were the highest yielders in full sunlight, producing over 2,000 pounds of market coffee per acre yearly. All the other varieties, except the lowest-yielding Columnaris, produced similarly. Under shade trees, yields were about 40 percent lower and there was no significant difference in productivity between the Mundo Nuevo, Yellow and Red Bourbon, Puerto Rico 401, Pacas, Villalobos, and Kent varieties. Somewhat larger beans were produced by all varieties when grown under shade than in full sunlight. The Mundo Nuevo and Puerto Rico 401 varieties yielded a high proportion of large-sized beans and produced about 5 pounds of market coffee for every 28 pounds of berries.

The objective of the study presented in this paper was to determine the performance as to yield of 16 Arabica-type coffee varieties intensively managed and grown both under light shade and in full sunlight.

EXPERIMENTAL PROCEDURE

Two coffee-growing experiments, one in full sunlight and the other under approximately 40-percent shade, were conducted at the Adjuntas Substation. Sixteen promising Arabica coffee varieties were planted in each of the two experiments using a paired-plot design with 15 replicates. Each experimental plot consisted of eight trees of one variety for a total of 128 trees per replication and 1,920 trees per experiment. The coffee seedlings were spaced at 6 feet \times 6 feet in both experiments. *Inga inga* (L.) Britton trees were planted at 24-foot intervals and pruned as needed to maintain the desired shade in one of the experiments.

The experimental sites were on Guama clay at an elevation of approximately 1,800 feet above sea level. The mean monthly temperatures varied from 59° to 82° F. during the years in which the varieties were compared. The mean minimum temperature varied from 50.11° in February 1965 to 65.83° F. in June 1969, and the mean maximum temperature from 77.35° in January 1965 to 84.94° F. in July 1963. The mean monthly rainfall was 5.83 inches, varying from 0.49 inches in February 1965, to 13.66 inches in September 1966. The annual rainfall varied from 50.34 to 75.99 inches.

The seedlings of the varieties grown under partial shade were planted during April 1964. The seedlings of the varieties grown in full sunlight were planted during December 1964. Varieties compared under both conditions were Villalobos, Padang, Mundo Nuevo, Red Bourbon, Red Caturra, K.P. 228, S-16, Barbuck Sudan, N-50, Harrar, Puerto Rico Selection, Enrea, Geisha, Mibirizi, Zegui, and R-3. Both experiments were conducted as far as possible following the latest cultural practices as recommended by the Agricultural Experiment Station of the University of Puerto Rico (3).

Yields of ripe berries were determined for all trees for 5 consecutive

years, from 1965 to 1969, in the partial shade experiment. In the full sunlight experiment, the yields of each individual tree were weighed from 1966 to 1969 or for four consecutive crops.

RESULTS AND DISCUSSION

VARIETIES GROWN UNDER PARTIAL SHADE

The varieties compared in the two experiments are similar in growth habit to the Puerto Rico Selection and Red Bourbon varieties, with the

TABLE 1.—*Yields of 16 Arabica-type coffee varieties intensively managed and grown under partial shade*¹

Yields of market coffee produced per acre yearly						
Variety	1965	1966	1967	1968	1969	Statistical mean
R-3	4.74	18.27	20.48	28.66	20.82	18.98 a
Harrar	4.44	19.43	19.65	33.23	13.45	18.87 a b
Mundo Nuevo	4.81	21.66	23.14	31.58	13.30	18.31 a b c
N-50	4.72	20.17	19.53	31.67	14.71	18.14 a b c
Red Bourbon	5.99	20.09	16.95	30.39	11.20	18.02 a b c
Mibirizi	5.11	17.89	17.73	28.65	15.51	16.64 a b c d
S-16	3.12	15.68	15.95	32.07	15.35	16.50 a b c d e
Geisha	3.08	13.45	16.10	27.83	11.02	15.18 b c d e
Padang	4.45	16.43	15.47	28.45	12.02	15.03 c d e
Zegui	2.83	13.42	17.99	29.59	15.43	14.94 c d e
K.P. 228	2.38	14.03	13.62	28.61	14.70	14.14 d e
Red Caturra	6.70	16.43	13.66	26.54	6.61	13.72 d e
Puerto Rico Selection	3.77	13.20	13.77	26.02	12.67	13.62 d e
Villalobos	4.70	15.05	14.16	25.53	8.47	12.74 e f
Barbuck Sudan	1.18	8.68	13.82	19.19	11.53	10.17 f
Enrea	1.88	5.49	7.84	14.99	10.99	9.76 f

¹ Yields are expressed in hundredweights of market coffee per acre, estimated from plot production.

exception of the semi-dwarf varieties Red Caturra and Villalobos. All the other varieties compared are of intermediate growth habit, differing from each other in specific agronomic characteristics, principally in such botanical characteristics as color of the young tip leaves, angle of the lateral branches to the vertical stem, blooming habit, luxuriant growth, and time of ripening.

The yields of the varieties grown under partial shade are presented in table 1. The combined statistical analysis of five crops indicated that the best yielders among the 16 varieties tested are R-3, Harrar, Mundo Nuevo, N-50, Red Bourbon, Mibirizi, and S-16. Their average yields were 18.98, 18.87, 18.31, 18.14, 18.02, 16.64, and 16.50 hundredweights of market

coffee per acre, respectively, with no significant statistical differences between them. Villalobos, Barbuck Sudan, and Enrea were the lowest yielders with no significant differences between their yields.

Higher yields than the average for the Island were produced by most of the varieties 18 months after being transplanted to the field, ranging from 1.18 to 6.70 hundredweights of market coffee per acre. Most of the intermediate varieties gave a greater total yield for a period of 5 years than the semi-dwarf ones, which tended to give a higher yield in the first year but

TABLE 2.—*Yields of 16 Arabica-type coffee varieties intensively managed and grown under complete sun exposure*¹

Yields of market coffee produced per acre yearly					
Variety	1966	1967	1968	1969	Statistical mean
Mundo Nuevo	11.68	25.72	41.80	30.97	26.93 a
R-3	6.94	15.66	30.50	35.51	24.58 a b
Harrar	8.42	20.21	33.20	33.32	24.55 a b
Mibirizi	8.10	18.49	34.51	37.53	23.77 a b c
S-16	4.86	18.75	30.46	33.78	22.74 a b c
Red Caturra	11.07	17.03	25.09	31.94	21.74 a b c
Red Bourbon	10.27	16.90	33.07	30.54	21.61 a b c
Zegui	6.59	17.55	29.88	27.55	21.52 a b c
Villalobos	9.50	17.64	22.99	28.55	21.29 a b c
N-50	7.51	16.56	32.83	31.42	21.17 a b c
Puerto Rico Selection	8.62	16.82	23.88	25.91	18.92 b c d
Padang	8.41	17.05	28.91	26.54	17.79 c d e
Geisha	4.30	10.46	17.89	28.38	15.52 d e f
Barbuck Sudan	1.97	16.61	20.13	16.71	12.76 e f g
K.P. 228	3.69	14.21	17.83	17.62	11.49 f g
Enrea	2.98	6.73	8.87	14.20	9.53 g

¹ Yields are expressed in hundredweights of market coffee per acre, estimated from plot production.

were surpassed by intermediate-growth varieties when the latter reached their mature size. For example, in its first crop Red Caturra was the highest yielder with 6.70 hundredweights of market coffee per acre but was surpassed by most of the intermediate-growth varieties in successive crops.

VARIETIES GROWN UNDER FULL SUNLIGHT

Table 2 presents the yield response of the varieties under comparison when grown without shade. As shown by the combined statistical analysis of four successive crops, the Mundo Nuevo, R-3, Harrar, Mibirizi, S-16, Red Caturra, Red Bourbon, Zegui, Villalobos, and N-50 are the highest yielders, with no significant statistical differences between them. Their average yields in hundredweights of market coffee per acre were 26.93,

24.58, 24.55, 23.77, 22.74, 21.74, 21.61, 21.52, 21.29, and 21.17, respectively. No significant differences were observed between the productions of Barbuck Sudan, K.P. 228, and Enrea which were the lowest yielders among the varieties compared.

All the varieties, with the exception of Barbuck Sudan, had higher yields in their first crop than the average production of the Island. The harvesting season was started 20 months after the coffee seedlings were transplanted to the field.

The semi-dwarf varieties performed better when grown under complete sun exposure than under partial shade. Both semi-dwarf varieties failed to show significant yield differences by comparison with Mundo Nuevo, the highest producer under complete sun exposure.

SUMMARY

The productivity of 16 varieties of Arabica-type coffee, grown under intensive management in full sunlight and beneath shade trees, was determined at the Adjuntas Substation.

A combined statistical analysis of five crops, grown under approximately 40-percent shade indicated that the best yielders were R-3, Harrar, Mundo Nuevo, N-50, Red Bourbon, Mibirizi, and S-16. Their average yields were 18.98, 18.87, 18.31, 18.14, 18.02, 16.64, and 16.50 hundredweights of market coffee per acre, respectively, with no significant statistical differences among them. The average production of the other varieties were: Geisha, 15.18; Padang, 15.03; Zegui, 14.94; K.P. 228, 14.14; Red Caturra, 13.72; Puerto Rico Selection, 13.62; Villalobos, 12.74; Barbuck Sudan, 10.17; and Enrea, 9.76 hundredweights of market coffee per acre, respectively.

The combined statistical analysis of four crops of the same varieties grown under complete sun exposure revealed no significant statistical differences between the yields of Mundo Nuevo, R-3, Harrar, Mibirizi, S-16, Red Caturra, Red Bourbon, Zegui, Villalobos, and N-50, with 26.93, 24.58, 24.55, 23.77, 22.74, 21.74, 21.61, 21.52, 21.29, and 21.17 hundredweights of market coffee per acre, respectively, but the differences in production when compared to the remaining varieties were significantly high. The remaining varieties and their production were Puerto Rico Selection, 18.92; Padang, 17.79; Geisha, 15.52; Barbuck Sudan, 12.76; K.P. 228, 11.49, and Enrea 9.53 hundredweights of market coffee per acre, respectively.

In general, higher yields were produced by the varieties when grown without shade. Much higher yields than the average production for the Island were obtained at both experimental sites (under and without shade) and most of the varieties produced over 200 pounds of market coffee 18 to 20 months after being transplanted to the experimental sites.

Most of the intermediate-growth varieties gave a greater total yield for a period of 5 years than the semi-dwarf ones, which tended to give a higher

yield in the first crop but were surpassed by the intermediate-growth varieties when the latter reached mature size.

RESUMEN

Se determinó la productividad de 16 variedades de café del tipo arábigo, cultivadas intensivamente tanto a pleno sol como bajo una sombra parcial de un 40 por ciento, aproximadamente.

El análisis estadístico combinando los datos de producción de cinco cosechas del experimento en donde las variedades se compararon en siembras bajo sombra controlada, indicó que las mejores fueron la R-3, Harrar, Mundo Nuevo, N-50, Borbón Rojo, Mibirizi y S-16. La producción promedio de estas variedades fue 18.98, 18.87, 18.31, 18.14, 18.02, 16.64 y 16.50 quintales de café pilado (café oro) por acre, respectivamente. No se encontraron diferencias estadísticas significativas entre estas variedades. La producción de las otras variedades fue la siguiente: Geisha, 15.18; Padang, 15.03; Zegui, 14.94; K.P. 228, 14.14; Caturra Rojo, 13.72; Selección Puerto Rico, 13.62; Villalobos, 12.74; Barbuck Sudan, 10.17; y Enrea, 9.76 quintales de café oro por acre.

El análisis estadístico combinando los datos de producción de cuatro cosechas de las mismas variedades cuando se cultivaron a pleno sol, reveló que no había diferencia significativa entre la producción de Mundo Nuevo, R-3, Harrar, Mibirizi, S-16, Caturra Rojo, Borbón Rojo, Zegui, Villalobos y N-50, cuya producción promedio fue de 26.93, 24.58, 24.55, 23.77, 22.74, 21.74, 21.61, 21.52, 21.29 y 21.17 quintales de café pilado (café oro) por acre, respectivamente. Las variedades Selección Puerto Rico, con 18.92; Padang, 17.79; Geisha, 15.52; Barbuck Sudan, 12.76; K.P. 228, 11.49; y Enrea con 9.53 quintales de café oro por acre fueron las que menos produjeron.

En general, los rendimientos más alto se lograron cuando las variedades crecieron a pleno sol. Se obtuvieron producciones mayores que la producción promedio en la Isla con la mayoría de las variedades cuando solo tenían 18 meses de sembradas en el campo, y al concluirse los experimentos los rendimientos de todas las variedades fueron mucho mayores que dicho promedio.

La mayoría de las variedades de crecimiento intermedio fueron mejores productoras que las semi-enanas por un período de 5 años, pero las enanas demostraron una tendencia a ser más precoces en su primer año de producción, siendo luego superadas por las variedades de crecimiento intermedio cuando éstas alcanzaron su mejor grado de desarrollo.

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