

# Arabica Selections with *Coffea eugenoides* and *C. canephora* Introgressions for Rondônia State in Brazilian Amazon<sup>1</sup>

H.P. MEDINA FILHO\*<sup>2</sup>, R. BORDIGNON\*, E.F. SOUZA\*\*<sup>2</sup>, A.L. TEIXEIRA\*\*\*<sup>2</sup>,  
J.M. DIOCLECIANO\*\*\*<sup>2</sup>, G.O FERRO\*\*\*<sup>2</sup>

\*Centro de Café – Instituto Agronômico de Campinas, Avenida Barão de Itapura, 1481, 13020-902, Campinas, SP, Brazil 1.Sponsored by Consórcio Pesquisa Café; 2.CNPq fellowship

\*\*Embrapa Semiárido, BR 428, Km 152, CP 23, 56302-970, Petrolina, PE, Brazil

\*\*\*Embrapa Rondônia, BR 364, Km 5,5, CP 127, 76815-800, Porto Velho, RO, Brazil

## SUMMARY

Among 126 Obatã backcross hybrids (BC<sub>2</sub>) with *C. arabica* x (*C. eugenoides* 4n x *C. arabica*) studied several years in Campinas, 24 were additionally selected for the eugenoides very late ripening, desirable by a cultivar for the tropical conditions of Rondônia State in the Amazon region of Brazil as a strategy to escape from rainy season during harvest. There, robustas thrive and arabicas are no longer grown due to a history of poor crops of low quality beans. Three F<sub>3</sub> lines of Catuaí x Glauca were also selected for lateness. In addition, 11 F<sub>2</sub> Arabusta populations were also studied, been one of *C. arabica* cv. Ibairi x *C. canephora* 4n, one of its reciprocal cross and 9 of Obatã x *C. canephora* 4n. Ripening check cultivars were represented by two very late Obatã lines, late Catuaí Vermelho and Catuaí Amarelo, medium two Paraíso lines and Topázio and by early Oeiras and Bourbon Amarelo. Plots were set up in Ouro Preto do Oeste (Lat 10°45'S, Long 62°15'W, Alt 300m, Temp 25°C, Rainfall 2000mm, Aw Köppen). Vigor and general plant characteristics were observed during growth seasons, yields recorded for three years and cup quality evaluated in the second crop. Greater variability was observed among lines and much less among individuals within them, except Arabustas. Control cultivars showed all medium to early ripening and except one Obatã confirmed the known poor performance, yielding 10 to 24 clean 60 kg bags/ha, global quality 1 to 3 (out of 5), SCAA scores 40 to 62. Obatã lines yielded 25-32 bags/ha, global quality 2-3, SCAA scores 56-58. F<sub>2</sub> Arabustas displayed scanty berry set and no one was selected. F<sub>4</sub> Catuaí x Glauca lines did not come up late, yielded or cup tested well. The 24 F<sub>2</sub>BC<sub>2</sub> Obatã x *C. eugenoides* backcrosses were the most promising. Many lines were remarkably late, several with impressive yields up to 45 bags/ha, global quality up to 4 and SCAA scores up to 80. Ninety-seven selected F<sub>3</sub>BC<sub>2</sub> were advanced and the two profuse crops of this generation displayed 28 progenies ripening of 3-4 weeks later, attesting the adequacy of germplasm choice and selection procedures. Late and very late F<sub>4</sub>BC<sub>2</sub> selections will be tried up also in neighboring Acre State.

## INTRODUCTION

With 2 million bags per year, Rondônia State in the Amazon region ranks fifth in coffee production in Brazil. Cultivation is almost exclusive of *Coffea canephora* [1] comprised approximately by 90% of Conilon and 10% of Robusta types [2]. Frequently a mixture of both is cultivated with reduced technologies by small farmers. The crop is exported to Southern States from where arabica coffee is imported for local consumption in blends.

Coffee was introduced in the State 40 years ago with Brazil's leading *C. arabica* Mundo Novo and Catuaí cultivars, nowadays replaced by *C. canephora*, due to a continuous

history of low yields and poor quality. Coffee regions are located in tropical conditions, 9-13°S latitudes, altitudes <300m, precipitations >1500mm, temperatures >24°C [2], technically recognized apt only for the cultivation of robustas. Arabicas require milder, subtropical climates.

Besides of poor agronomic performance, even the latest arabica cultivars ripe too early, in February-March. Rain is still frequent, turning harvesting and drying difficult operations, yielding low quality grains and beverage. Thus, ideal arabicas should be very late and adapted to tropical conditions, attributes not found in current cultivars.

In the breeding program of IAC, the following germplasm deserved attention by their specific attributes or origins and were selected as the diversity putatively suitable to be studied in the aforementioned conditions of Rondônia.

At high latitudes of Southern States, *C. arabica* cv. Obatã has performed also very well in hot climates as far as irrigation is provided. Obatã is a rust resistant cultivar developed at IAC from a cross of *C. arabica* cv. Vila Sarchi and Timor Hybrid [3] the later a natural cross derivative of *C. arabica* x *C. canephora* [4]. Besides the rust resistance, *C. canephora* conceivably contributed to the lateness and high temperature adaptation genes of Obatã, since those characteristics are not observed in Vila Sarchi cultivar but are common to *C. canephora*. Campinas germplasm evaluations have revealed also that *C. arabica* Ethiopian accession Glauca ripens later than Catuaí, a widely planted late cultivar. The same was true for several Arabustas, hybrids of *C. arabica* x *C. canephora* 4n that in Campinas ripens as late as the robustas and have cup quality superior to them. Hopefully genetic segregation of F<sub>2</sub> would provide genotypes with improved outturn, cup quality closer to arabicas, better adaptation to tropical conditions and the necessary easy vegetative propagation capacity of robustas.

As to cup quality, cv. Ibairi of *C. arabica* has shown superior beverage. Likewise, ongoing program exploits *C. eugenoides* as source of quality in introgressed *C. arabica* lines. This diploid species is very late in Campinas conditions and is regarded as the female genitor of *C. arabica* and the source of good cup quality genes [5] provided *C. canephora* is the male genitor. Among Campinas high yielding hybrids and breeding lines with good cup quality, special selections were made for lateness. Field evaluations, local selections and ensuing progeny tests were effected in Rondônia.

Present investigation reports the results of this joint effort of Instituto Agronômico de Campinas and Embrapa Rondônia aiming at the development of arabica cultivars adapted to Rondônia and similar tropical states.

## MATERIALS AND METHODS

Among 126 Obatã backcross hybrids (BC<sub>2</sub>) with *C. arabica* x (*C. eugenoides* 4n x *C. arabica*) studied several years in Campinas as to stature, vigor, yield, maturation, bean characteristics and beverage profile, 24 were additionally selected for the *C. eugenoides* very late ripening. Three F<sub>3</sub> lines of Catuaí x Glauca were also further selected for lateness. Ripening check cultivars were represented as follow: two very late Obatã IAC 1669-20 lines, one late Catuaí Vermelho IAC 15, one late Catuaí Amarelo IAC 62; two medium Paraíso lines, H419-10-6-2-10 and H419-10-6-2-3-27, one medium Topázio MG 1190; one early Oeiras MG 6851 and one early Bourbon Amarelo IAC J10. All are commercially grown in Southern Brazil. This 36 items plot was set up in three replicated blocks, 10 plants per treatment and is referred as Plot IA. Plot IB comprised 11 F<sub>2</sub> Arabusta populations represented by over 30 plants of each cross. One was of *C. arabica* cv. Ibairi x *C. canephora* 4n, one of its reciprocal cross and 9 of Obatã x *C. canephora* 4n. Vigor and general plant characteristics were observed during

growth seasons and yields were recorded for three years. Cup quality was evaluated in Campinas in the second crop samples.

Phenotypic plant selections were made on March 2008 originating  $F_3BC_2$  evaluated in Augmented Block Design referred to as Plot II. In 2012, phenotypic selections were effected giving rise  $F_4BC_2$ . Plots I and II were set up in Ouro Preto do Oeste (Lat 10°45'S, Long 62°15'W, Alt 300m, Temp 25°C, Rainfall 2000mm, Aw Köppen), at 3 x 1m spacing.

## RESULTS AND DISCUSSION

With reference to Plot IA, as expected, greater variability was observed among such genetically diverse lines assayed and much less among individuals within them. Decreased within lines variability was also expected on the basis of careful selection among progenies and their elite individuals selected in previous  $BC_2$  Obatã backcross generation. Control cultivars showed all medium to early ripening and except one Obatã confirmed the known poor performance, yielding the equivalent of 10 to 24 clean 60 kg bags/ha, global quality 1 to 3 (out of 5), SCAA scores 40 to 62. Obatã lines yielded 25-32 bags/ha, global quality 2-3, SCAA scores 56-58.  $F_4$  Catuaí x Glauca lines did not come up late, yielded or cup tested well, with 15 to 26 bags/ha, global cup scores 2, SCAA 52-56. Nevertheless, seven uniform ripening plants were selected for progeny tests. The 24  $F_2BC_2$  Obatã x *C. eugenoides* backcrosses were the foremost promising. Most lines were remarkably late, several with impressive yields up to 45 bags/ha, global quality up to 4 and SCAA scores up to 80. Ninety-seven  $F_3BC_2$  were phenotypically selected to be progeny tested. These 97 selected lines in Rondônia traced back to 20 late Obatã  $BC_2$  selected in Campinas.

As to Plot IB the observed results were not encouraging. Although late,  $F_2$  Arabustas displayed scanty berry set despite the fact that most plants had quite luxuriant foliage, lavish blooming and pollinators were abundant. No one was selected for further investigations on grain characteristics and rooting ability. Such behavior was somewhat unexpected by the results of sister  $F_2$  populations grown in Campinas, where some late segregants have shown good yields, improved outturn compared to  $F_1$  and cup quality inferior to arabica but conspicuously better than robustas. This investigation attempts robusta type plants with improved beverage and certainly would not be truly comparable to arabicas.

Regarding to Plot II (Figure 1) that corresponds to the ensuing generation it comprised 120 items, being 16 controls, 7  $F_5$  Catuaí x Glauca and 97  $F_3BC_2$  Obatã x *C. eugenoides* backcrosses. Among them, 69 were rated as medium-early maturation at the second crop year, and 35 as late, ripening 3-4 weeks after other germplasm and control ripening cvs. In 2012 grain characteristics of second year crop were quite acceptable, average screen 16.4 with over 70% screen 16 and above, with peaberries less than 16%. Results of cup analysis of dry processed samples varied from hard to soft but it can be surely improved by ameliorating processing.

Among the 35 late progenies, 28 were elected from which 98 single plant selections constitute the advanced  $F_6$  and  $F_4BC_2$  generations to be evaluated in Rondônia and neighboring Acre State. Considering the general uniformity within lines, the grain analysis and the two profuse crops of Plot II it is anticipated that selections in  $F_6$  and  $F_4BC_2$  are at final stage. The results attest the germplasm choice and selection procedures. Hopefully they represent the forerunners of arabica return to Rondônia.

**Figure 1:** Above: F<sub>3</sub>BC<sub>2</sub> selected line of *C. arabica* Obatã x *C. eugenioides* grown in Rondônia State. Below: Early and late ripening plants.

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