HARC Update

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Origin and variety/ cultivar of coffee

Origin = The place coffee was grown ie: Kona, Kenya

Variety/Cultivar= ie. Typica, Bourbon

Common Name	Origin	Cultivar
Blue Mountain	Jamaica	Typica, Blue Mountain
Sumatra Mandhaling	Indonesia	SL28, Lintong
Kenya AA	Kenya	SL28, Ruiru11
Ethiopia	Harrar, Yelgacheffe	Arabica mix varirties
Kona	Kona	Typica
Costa Rica	Tarazu	Catuai, CostaRica95
Guatemala Antigua	Antigua	Caturra, Bourbon

Cultivars of arabica coffee

- Botanical varieties: Typica, Bourbon
- Mutants: Caturra (*Ct*), Maragogipe (*Mg*), mokka (*molr*), laurina (*lr*), San Ramon(*SR*)
- Semi Wild arabica accessions: Geisha
- Hybrids among arabica coffee:

  Mundo Novo: High yield selection of Bourbon types

  Red and Yellow Catuai (Mundo Novo x Caturra)

  SL28

  Pacamara: Maragogipe x Pacas select
- Hybrids with Timor Hybrid (natural cross of Arabica x Robusta) =CLR resistant

  Catimor - Central America

  Icatu – Brazil

  Tupi,Obata (Sachimore) - Brazil

  Ruiru 11 - Kenia

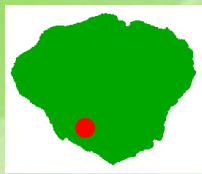
Steps for Cultivar Development by Plant Breeding

1. Understanding of the nature of the genetics and reproductive system of plants
2. Select the parents based on the traits to combine
3. Hybridization
4. Selection
5. Propagation

Milestones of Coffee Cultivar Development in Hawaii

1. 1950s : Imported over 30 varieties of arabica and wild species of Coffea to Hawaii.(Dr. Hamilton, UH)
2. 1980s : Field trials of 20+ arabica varieties at 10+ locations on 5 islands. (Cavaletto and Bittenbender , UH)
3. 1997: Dr.Medina consulted by HCGA for cultivar development
4. 1998: Established a field of cultivars of Hawaii at HARC Kunia for the breeding project (Nagai and Osgood, HARC, and HCGA)
5. 1999: 1st Hybridization of arabica varieties (Nagai, HARC)
6. 2000-2007: Selection of superior trees at HARC and Growers fields (HARC, Kauai Coffee, HCGA)
7. 2012-13: Distribution of Tissue cultured plants of 3 selected hybrids
8. 2017: 1st Commercial product of an unique Hawaiian curtivar (Tom Greenwell)

Genetic Resources
(Parents)



Kauai

yellow Catuai
red Catuai

Oahu

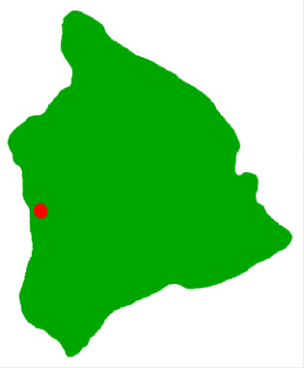
mokka hyb.
Promecafe

Molokai

red Catuai
red Caturra

Maui

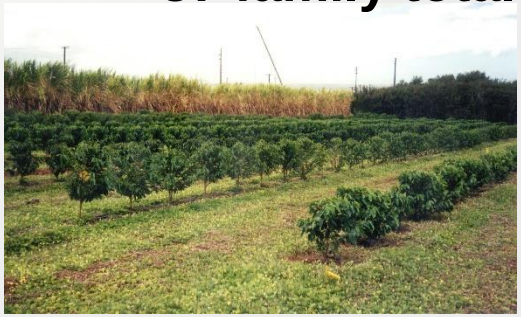
mokka
red Catuai



Kona

'Guatemalan'
typica
'Old Hawaiian'
Hawaiian

37 family total



Via seed and cuttings

Common Field
Kunia, HARC
planted April,1998

Crosses (spring 1999)

Group	# of crosses
mokka and other arabica varieties	66
with Promecafe (Catimor)	53
with Icatu	8
mokka and other selfs	40
Total	167

- **H99 - series Progeny(1,500)**
- **H00- series (400)**

Coffee Germplasm at HARC -1

Publically available varieties/ accessions

Group	Description	Genotype	Source		Tree #	Owner
HI commercial	Typica	4	Kona		72	HARC/ public
	Catuai	10	Maui, Kauai, Molokai		150	HARC/ public
	Caturra	2	Molokai, UH		35	HARC/ public
	Yellow Catuai	2	Kauai		40	HARC/ public
	Mokka	4	Maui		80	HARC/ public
	Mokka hybrid	5	Oahu		100	HARC/ public
	Catuai odd type	1	Molokai		15	HARC/ public
Other commercial	P502	1	UH HSPA trial1988		10	HARC/ public
	Maragogipe	1	UH HSPA trial1988		11	HARC/ public
	6549	1	UH HSPA trial1988		12	HARC/ public
	6661	1	UH HSPA trial1988		12	HARC/ public
	San Ramon	1	UH HSPA trial1988		12	HARC/ public
	Pacas	1	UH HSPA trial1988		11	HARC/ public
	Yellow bourbon	1	UH HSPA trial1988		12	HARC/ public
	Kents	1	UH HSPA trial1988		9	HARC/ public
	Blue mountain	1	UH HSPA trial1988		12	HARC/ public
	Preger	1	UH HSPA trial1988		11	HARC/ public
	Guadalupe	1	UH HSPA trial1988		12	HARC/ public
	SL28	1	Kauai Coffee		6	HARC/ public
Catimor	8667-6,5775-7-1	2	Promecafe (1)		45	HARC
Canephora	C. canephora	1	UH HSPA trial1988		7	HARC/ public
		43			674	

Use of mokka germplasm as parents

Goal:

The introgression of Mokka flavor traits into high yielding and larger bean size cultivars

- Mokka is an arabica coffee variety (*C. arabica*) originating in Ethiopia. Historically Mokka coffee was exported from Mokka port in Yemen.

- Mokka was introduced to the Univ. of Hawaii coffee germplasm collection in the mid 1950s

- The original Mokka is considered as a mutant of Bourbon (C alvalho et al 1965)

- Commercially cultivated on Maui (Kaanapali Coffee Co). The accession is considered to be a Mokka hybrid. (by Medina)

- The cupping quality of Mokka hybrid was evaluated excellent by coffee cuppers in US but bean size is very small (about 30-40% of Red Catuai beans).

Mokka germplasm at HARC Kunia Station

The original mokka (short mokka)

From Dr. Medina, Campinas

Mokka:MA2-7

Mokka hybrid 'Ibairi'

Field of various Mokka hybrids

Examples of genetic traits for arabica coffee breeding

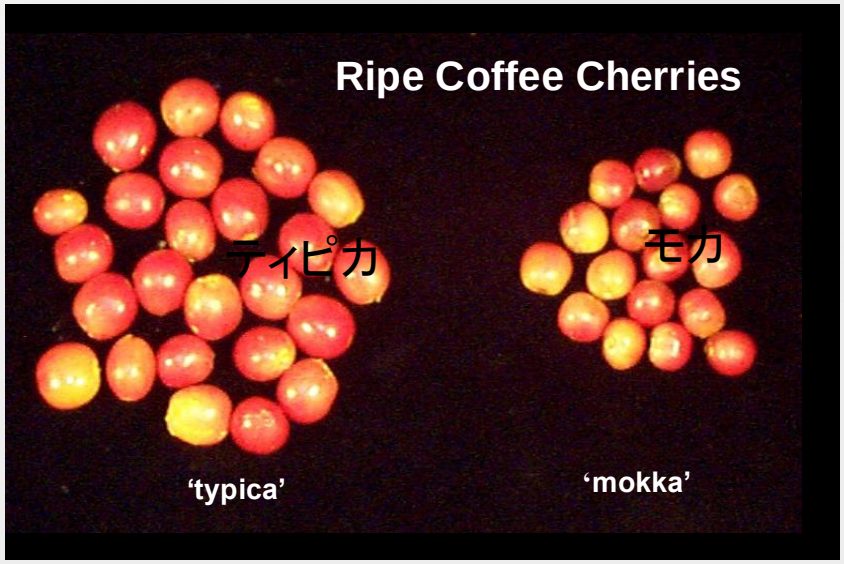
- Pest and Disease Resistance
  CLR(Coffee Leaf Rust) ,CBD (Coffee Berry Disease)

- Unique Cupping Quality and other components
  non- caffeine coffee

- Beans and tree characters:
  bean size, shape, tree height

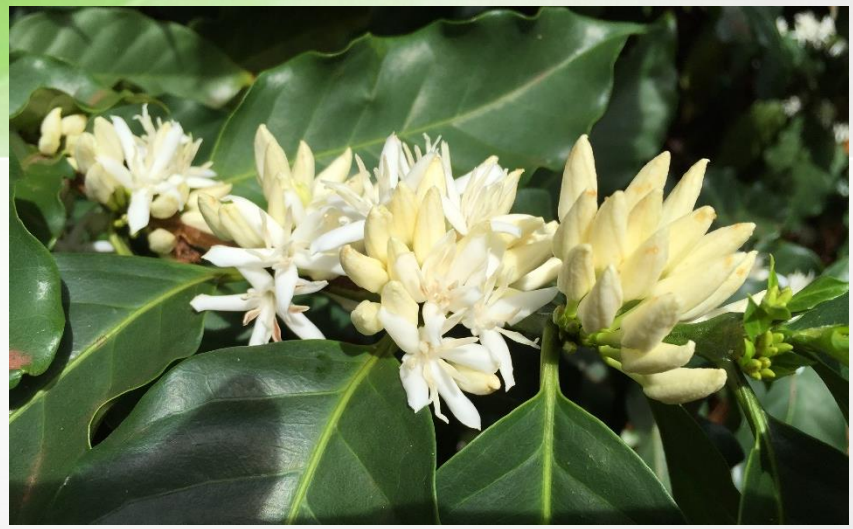
- Advantage for cultivation:
  drought tolerance, mechanical harvestability

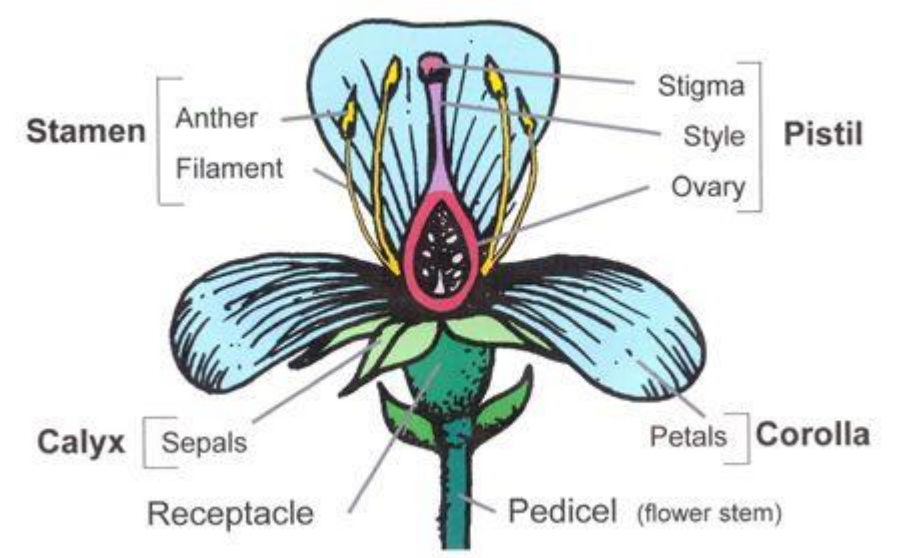
Typica vs. Catuai



Hybridization and Selection

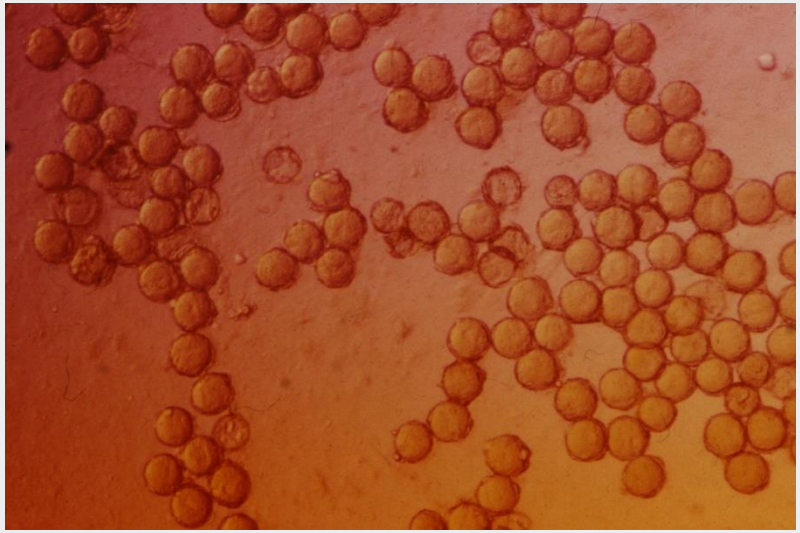
Flowering of Arabica Coffee





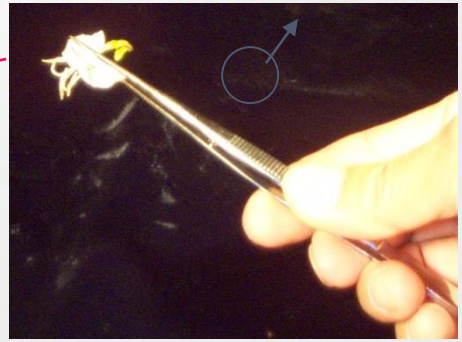
https://www.pinterest.com

Pollen of coffee (x 200)



Hybridization of coffee

Pollination



Fruit/seed development

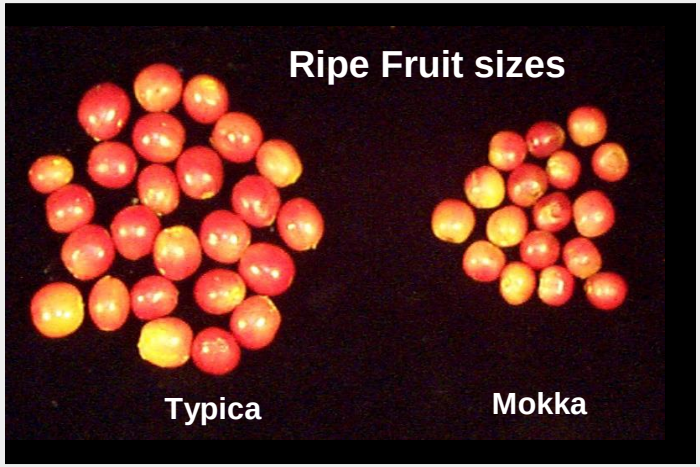
Harvest: 6-7 months from pollination

Fruits of Mokka and a Mokka Hybrid

Developing fruits

Mokka:MA2-7

Ripe fruits



H99-36:
MA1-12 x Margogipe
(mokka select)

Evaluation of 1999 Progeny (H99-) at HARC Kunia Station (2001 and 2002)

- **Increased bean Size**
  - Yellow catuai x Margogipe
  - Mokka hyb. Self
  - Mokka x Red Catuai
- **Tree height**
  - Red Catuai x Mokka hyb
  - Red catuai dwarf x mokka hyb
  - Red Catuai x typica
  - SanRamon? x mokka
- **Cupping Quality**
  - Red Catuai x SL28
  - Mokka hyb self
  - Red Catuai x 6661

F2 Segregation of hybrid famil

List of 12 F1hybrid families selected at HARC Kunia and their parentage

Hybrid #	Parentage	Pedigree
H99-54	OA13-5 self	Blue Mtn x Mokka Hyb self
H99-56	MA8-3x MA1-12	Red catuai x Mokka Hyb
H99-60	MA10-5 self	Mokka Hyb self
H99-74	#6661x Catuai	#6661xCatuai
H99-131	BMT1x 6661	Typica x 6661
H99-150	MA6-2x SL28	Red Catuai SL28
H99-153	MA7-1 x SL28	Red Catuai SL28
H99-160	MO24-8 x mocha2	Red Catual x mokka
H99-169	OA13-1 BMT-1	BMT Mokka x Typica
H99-22A	MA1-12 self	Mokka Hyb self
H99-36	MA1-12 x Maragogipe	Mokka Hyb x Maragogipe
H99-43	MA10-5 x Y.Bourbon	Red Catuai x Bourbon
KA17	Yellow Catuai	
KO34	Typica	

Field trial of selected F1 hybrid families at Kauai coffee (2004-2007)

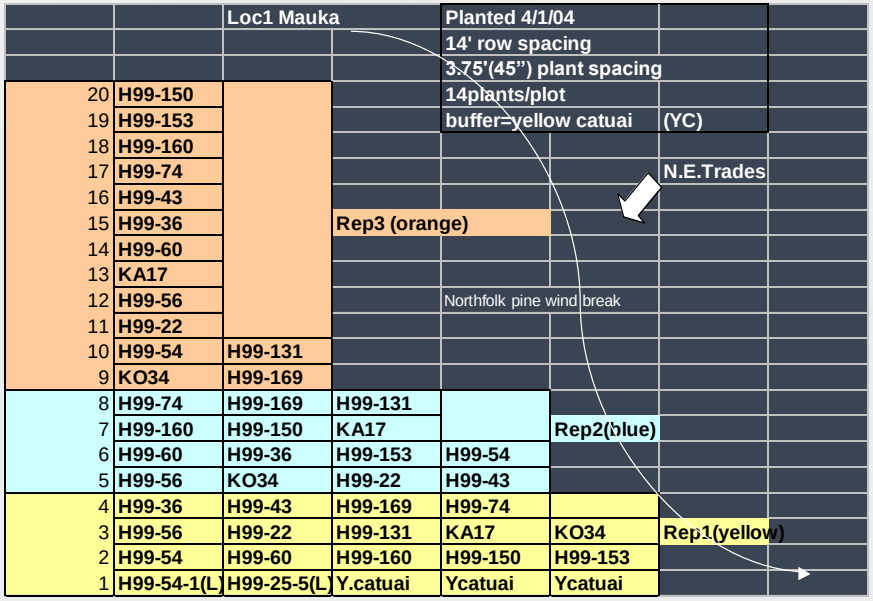
Objective: Field evaluation of selected coffee hybrid families at a commercial coffee field

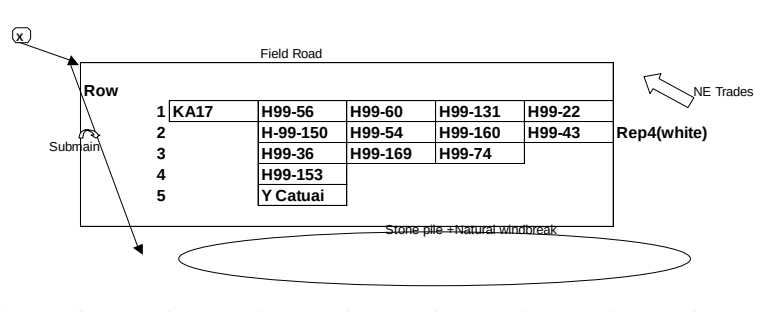
Experimental Design : RCB

14 Entries:12 new hybrid families
2 check varieties: Yellow catuai (KA17) and Kona typica (KO34)
2 Location with 4 reps
14 trees/plot
(14 x 3.75 ft spacing- Kauai Coffee Standard)

Location1 , Rep2 view

Experimental Design



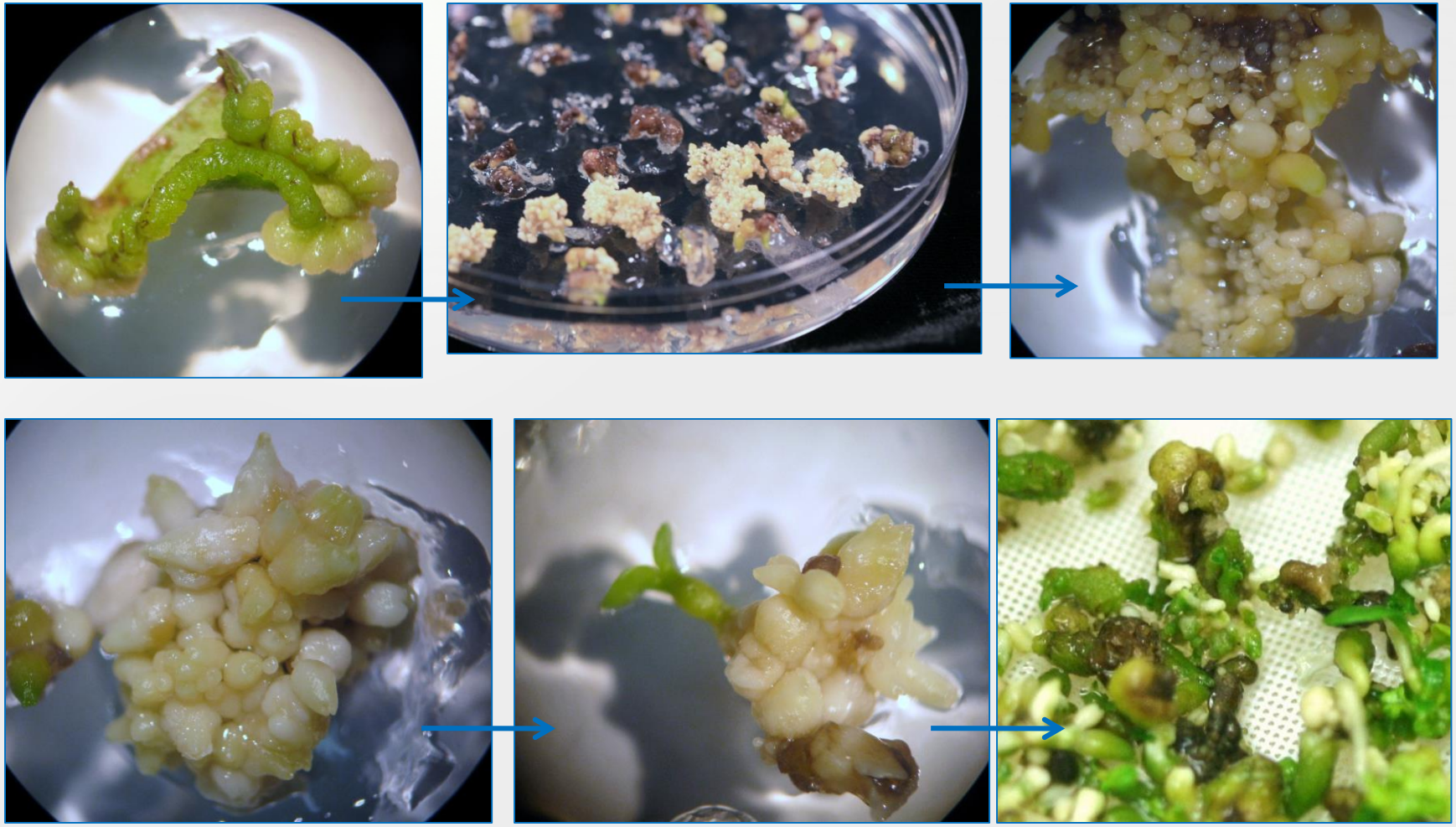


Kauai Coffee Field Trial

Field Planting 4/1/04

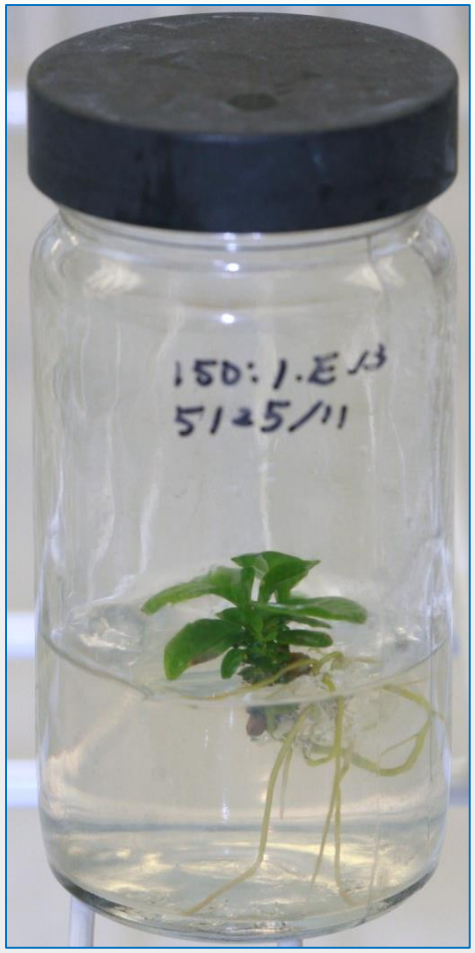
Propagation

Cloning/ Tissue Culture of Selected Hawaiian Arabica Hybrids



Sub-contracted from HCA/ HCGA for SCBGP-FB, 2010-2012

Acclimatization:
Sterile environment to soil



Clones of New F1 and F2 Hybrids

Clones (via tissue culture) of top 3 F2s (H99-153,H99-150 and H99-160) were distributed to HCGA members and HARC Maunawili station in 2012.

H99-36 F1

H99-36 F5 Development and Selection HARC/ HCGA/ Greenwell Farms

F1: Original Hybrid H99-36 1999

HARC Kunia MA1-12 x Maragogipe
(mokka hybrid)

F2:Kauai Coffee Trial 2004 39 trees (seeds from 3 F1 trees)

F3: Greenwell Farms, Kona 9 trees (seeds from 1 F2 tree)
Planted 2007

Cupping at various times

F4: Greenwell Farms, planted (seeds from selected 6 F3 trees) in 2011

F5:Greenwell Farms, Kona planted (seeds from selected F4 trees) in 2015

F3 Planting at Greenwell Farms at Kona

F4 Trees planted in 2012

H99-36 F5 at Greenwell Farms

H99-36 F5 Flowering in 2017

HARC Coffee Research Team and Collaborators

HARC
- Dr. Chifumi Nagai
- Dr. Ming Li Wang
- Nick Dudley
- Tyler Jones
- Lance Santo (Agronomy consultant)
- Jayme Barton
- Kyle Onaga, Emma Smith
- Juli Burden

Hawaii Coffee Growers' Association (HCGA)

UH- CTHAR
- Andrea Kawabata

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- Dr. Koichi Nakahara et al.

World Coffee Research (WCR)

University of Illinois
- Dr. Ray Ming

Texas A&M University, Dallas
- Dr. Qing Yi Yu

Mi-Cafeto, Tokyo, Japan
- Jose Kawashima

2007 HCGA at Kona