/ Dr. Oded Achilea

A. SOME BOTANICAL FACTS

The commercial coffee plants belong to the family *Rubiaceae*, they are *Coffea arabica and coffea canephora,* mostly native to tropical Africa. The main variety of *C. canephora* is called ꞌRobustaꞌ. They are evergreen shrubs or small trees. The small fragrant white or pink flowers frequently open after a dry period and may be open for a few days only. The fruit, known as a "coffee cherry," is a one- or two-seeded drupe, and depending on the species, it can be red, purple, yellow, orange, blue, or black when mature. The "coffee beans" are the rounded oblong seeds, each with a flat face, marked by a lengthwise groove.

Ripe ꞌ*Arabica*ꞌ coffee fruits	Crude coffee ꞌbeansꞌ
Reference: Wikipedia	

ꞌ*Arabica*ꞌ is more widespread in cultivation, and more pest-sensitive than ꞌ*Robusta*ꞌ. It requires a cool subtropical climate, with a lot of moisture, hence it performs best at elevations of 600–2,000 meters (2,000–6,500 feet).

The rounder, more convex ꞌ*Robusta*ꞌ bean, as its name suggests, is hardier and performs well at lower altitudes, between sea level and 600 meters. ꞌ*Robusta*ꞌ coffee is cheaper to produce, has twice the caffeine content of ꞌ*Arabica*ꞌ, and is typically the bean of choice for inexpensive commercial coffee brands.

B. CENTRAL ROLE OF THE MINERAL NUTRITION

The maximum attainable yield of a certain plot can be reached, depending on appropriate management of the trees, like pruning, stumping and adequate control of weeds, pests and diseases, but even more so- on the availability of nutrients to the trees. Coffee plants need to be continuously supplied with mineral nutrients, in order to maintain their vegetative and reproductive growth, as well as, to compensate for the nutrients exported from the soil in the form of harvested fruits. Naturally, the soil properties strongly affect the availability of the applied nutrients to the crop. The best soil pH for coffee plantations is at 5.0–5.5.

C. NUTRIENT RATES DURING FIRST THREE YEARS

Table 1: The recommended application amounts and schedule for the first three years of ꞌ*Arabica*ꞌ plants.

| Year	Manure	N	P_2O_5	K_2O	Lime
	(kg/tree)	(g/tree)			
During planting	5	9.2	49.5	5.8	300

Mineral nutrition of coffee plantations in Vietnam and under similar conditions

	0	23	16.5	11.6	---
2	5	36.8	9.9	23	---
3	0	46	16.5	52.2	200

Application location for young trees.

Any crop plant takes up nutrients with its root hairs. These hairs are mostly found on the tips of the root system. These root tips are found roughly at the canopy circumference. Therefore, the preferrable location of the application changes over time, according to the development of the tree's canopy and root system. In the following figures, the tree's canopy is expressed by the green circle, while the fertilizers application zone is shown as the brown circle. But on the third year and later, only the gray sections on both rows' sides are normally treated.

First year	Second year	Third year
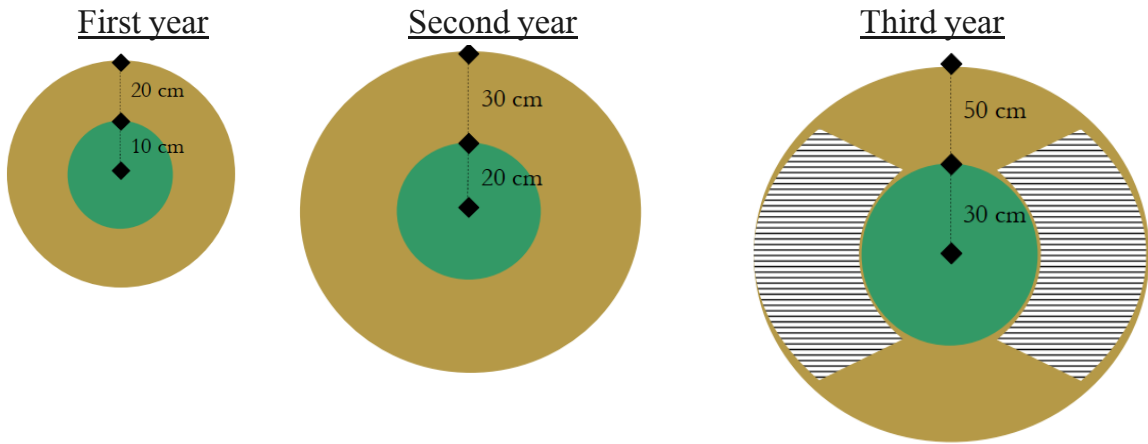
Reference: Kuit, M., Jansen, D.M., and Van-Thiet, N. 2015. Tan Lam Manual for Arabica Cultivation.

As long as the plantation is not equipped with a fertigation system, the fertilizers can be applied manually, as shown in the following photos.

A. Digging a shallow furrow parallel to the canopy contours.	B. Fertilizer application.
C. Mixing soil and fertilizer, to get an even distribution.	D. Covering the furrow

Reference: Kuit, M., Jansen, D.M., and Van-Thiet, N. 2015.
Tan Lam Manual for Arabica Cultivation.

If the young plantation is equipped with micro-irrigation and fertigation systems, the fertilizers of choice are members of the Gat fertilizers' "**Gatit**" specialty fertilizers family, as follows.

- ✓ <u>During planting,</u> the best fertilizer is **Gatit-RC** 1-5-0.5 (N:P:K), plus micronutrients, biostimulants and **Blu***, at a rate that will supply N at 9 g/plant, P_2O_5 at 50 g/plant, and K_2O at 6 g/plant.
- ✓ <u>During the 1st year,</u> the best fertilizer is **Gatit-RC** 2-1.5-1 (N:P:K), plus micronutrients, biostimulants and *Blu*, at a rate that will supply N at 23 g/plant/year, P_2O_5 at 17 g/plant/year, and K_2O at 12 g/plant/year.
- ✓ <u>During the 2nd year,</u> the best fertilizer is **Gatit-RC** 4-1-2 (N:P:K), plus micronutrients, biostimulants and *Blu*, at a rate that will supply N at 37 g/plant/year, P_2O_5 at 10 g/plant/year, and K_2O at 23 g/plant/year.
- ✓ <u>During the 3rd year,</u> the best fertilizer is **Gatit-RC** 2.5-1-3 (N:P:K), plus micronutrients, biostimulants and *Blu*, at a rate that will supply N at 46 g/plant/year, P_2O_5 at 17 g/plant/year, and K_2O at 52 g/plant/year.

Blu is a potent nitrogen stabilizer that markedly enhances plants' nitrogen use efficiency.

D. NUTRIENTS RATES AT THE PRODUCTIVE STAGE?

After the 3rd year in the field, the plants start their productive phase, so, they should be fertilized according to their expected nutrient removal by the yield, and by anticipated losses, like nutrients percolation and their washing off by heavy rain showers.
Expected removal by the yield, depends on:

A. Yield estimation, to be performed before the first fertilizer application, just after flowering, at the pinhead stage, (when fruitlets are 2-4 mm in diameter).
B. Nutrient contents of the estimated yield, during harvest.

The following data are actual examples of A. and B. patameters, carried out in Khe Sanh, Vietnam (Pinkert, 2002).

- ✓ Cherries fresh weight: 0.99 kg/1,000 cherries.
- ✓ Trees population: 4,000/ha.
- ✓ Mean number of cherries/tree: 4,797.
- ✓ Hence, estimated yield: 4,797 / 1,000 * 0.99 * 4,000 = 19,000 kg/ha
- ✓ N-P-K contents of the abovementioned 1,000 kg cherries: N=5kg; P_2O_5=0.89kg; K_2O=7.5kg.

Therefore, a crop of 19,000kg/ha will remove N=95kg/ha; P= 16.9kg/ha; K= 142.5kg/ha

Additional fertilizers should be applied to the soil of these plantations, for adequate maintenance of the trees' leaves, branches and roots, and to compensate for nutrients lost by percolation and washing off. The standard coefficients for Vietnam are: N=1.375; P=1; K= 1.235.

Therefore, the total annual recommended application rates (kg/ha) are:

**N=130; P_2O_5= 16.9; K_2O= 176**

E. APPLICATION TIMING

Nutrients requirements of the coffee tree vary over the year, and depend on the age of the tree, expected harvest and weather conditions. For example, nutrient requirements will be greater during the filling stage then during the pinhead stage. Also, the type of nutrients in greatest demand varies with the seasons.

Seasonal nutrient application schedule for mature (fruit-bearing) *'Arabica'* coffee plants in Vietnam.
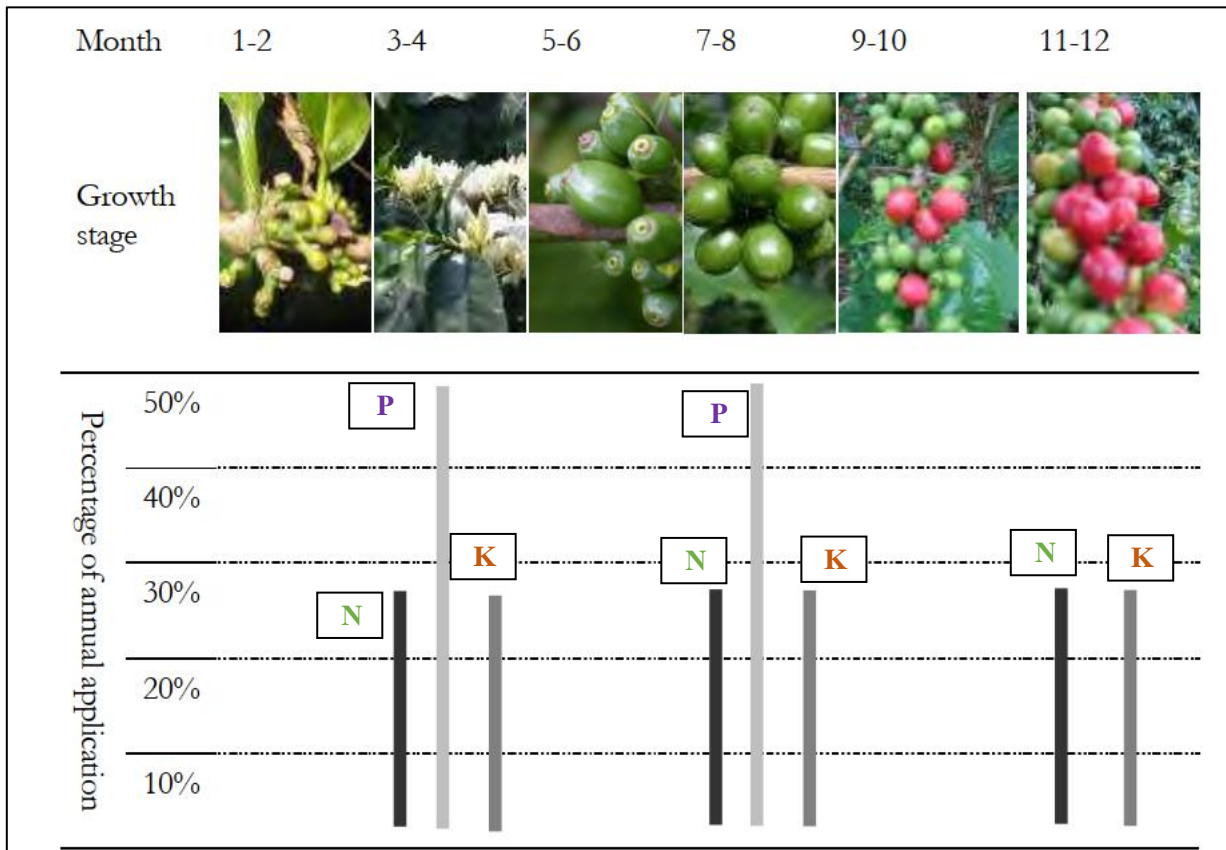
Reference: Kuit, M., Jansen, D.M., and Van-Thiet, N. 2015. Tan Lam Manual for Arabica Cultivation.

Given that the plantation is equipped with micro-irrigation and fertigation systems, the fertilizers of choice are the following Gat fertilizers' specialty fertilizers.

- ✓ During flowering stage (March-April), the best fertilizer is **Gatit-RC** 4-1-6 (N:P:K), plus micronutrients, biostimulants and **Blu***, at a rate that will supply N at 43 kg/ha, P_2O_5 at 8.5 kg/ha, and K_2O at 60 kg/ha.
- ✓ During cherries' bulking-up stage (July-August), the best fertilizer is **Gatit-RC** 4-1-6 (N:P:K), at the same rates as in the flowering stage.
- ✓ During the final ripening and color development of the cherries (November-December) The best fertilizer is **Gatit** 3-0-4 (N:P:K), at a rate that will supply N at 43 kg/ha, and K_2O at 60 kg/ha.

***Blu** is a potent nitrogen stabilizer that markedly enhances plants' nitrogen use efficiency.

F. CONTROLLING NUTRIENT DEFICIENCIES

All plants show their nutritional condition by the look of their leaves, and the educated grower should pay attention to these symptoms, interpret them correctly and control the problem accordingly. Following, please find some clear symptoms of mineral nutrient deficiencies

Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)
Magnesium (Mg)	Iron (Fe)	Zinc (Zn)	Boron (B)

Reference: Kuit, M., Jansen, D.M., and Van-Thiet, N. 2015. Tan Lam Manual for Arabica Cultivation.

expressed by *'Arabica'* trees.

An important additional tool to control nutritional deficiencies, is performing regular leaf analyses. The following table depicts normal contents of nutritional elements in *'Arabica'* coffee plants.

Optimum leaf nutrient levels (in dry matter) for *'Arabica'* coffee grown in full sun
Reference: Ashton, D., Webber, J. and Woods, R. 2014. Australian subtropical coffee grower's manual.

Nutrient	N	P	K	Ca	Mg	S
Optimum range	2.5-3.0%	0.15-0.2%	2.1-2.6%	0.7-1.5%	0.2-0.4%	0.02-0.1%
Nutrient	**Cu**	**Zn**	**B**	**Mn**	**Fe**	
Optimum range	16-20 ppm	15-30 ppm	40-100 ppm	50-100 ppm	70-200 ppm	