



BRIEFING NOTE 1 – January 2013

LA ROYA

Introduction

There have been a lot of newswire stories about the recent spread of “La Roya” in Central America and Mexico. The governments of Costa Rica, Guatemala and Honduras have declared national emergencies because of their concern about the sudden spread of *La Roya* in the current year. A meeting of Central American coffee authorities estimated that the disease had decreased the regional crop by 2.8 m. 60 kg bags in the current year, and that there will be an additional loss to the crop of 1.4-2.8 m. bags in the 13/14 coffee year. The outbreak in Central America follows the “epidemic” of La Roya that hit Colombia from 2008-2010 and had such a damaging impact on the country’s coffee crop. The estimates coming from Central America have been greeted with scepticism by the market, with many traders noting the tendency of Central American countries to lower crop forecasts during the harvest- and then raise them again at the end of the year. We believe there is a real problem in Central America, but also that it is too early to put an exact figure on the damage to the current crop, let alone the 13/14 crop. The problem has appeared very rapidly, and seems to have caught traders and farmers by surprise, increasing the difficulty of estimating the exact size of the damage. The crop loss in the current year should become clear as we move through February and the end of the harvest in Central America. The scale of the damage to the 13/14 crop (for reasons given in the text) will only become clear after the flowerings from around March. *This briefing note, for these reasons, does not attempt to give figures on crop loss, but instead, presents a short introduction to the disease and its impact on the coffee tree.* It is presented with the hope that it may sort out fact from fiction when reading reports of the disease and its spread in the Central America.

What is it?

La Roya is a fungal disease that is parasitic solely on the leaves of coffee plants. The formal scientific name of the fungus is *Hemileia vastatrix*, and it is also known as “Coffee Leaf Rust” in English or “Ferrugem” in Portuguese. La Roya is the most widespread, serious disease of coffee and is present in all major coffee origins. It is probably responsible worldwide for more lost coffee output than any other disease. The losses are concentrated in arabica coffee because robustas have some immunity to the disease; La Roya can be detected on the leaves of robusta plants, but it does not cause the strong leaf drop which accounts for the big losses in arabica output.

The disease was first noted in Asia during the nineteenth century, where it was responsible for the decimation of Sri Lankan arabica plantations and the demise of the country as a major coffee producer. It was then found to be present across African origins. La Roya was first observed in South America in the 1970’s when it was found on a farm in Bahia, Brazil. The outbreak in Bahia was



Active La Roya spores on leaf with dead leaf near stalk

caught too late to prevent the spread of the fungus to the rest of Brazil and eventually throughout S. America.

It is easy to spot the presence of La Roya in coffee plantations. It can be seen as yellowish spots on the underside of coffee leaves. These spots grow to a diameter of around 2 cm and become powdered with the spores of the *Hemileia vastatrix* fungus (see photo) - spores are the dormant, reproductive cell by which the fungus spreads. The yellowish spots are often discoloured by white powdery deposit; this is caused by a fungus *Verticillium lecanii* which is parasitic on the La Roya fungus. *Verticillium Lecanii* by itself is not thought to cause any damage to coffee. The fungus penetrates through the stoma of the leaf and colonises its tissues from where it can spread through the leaf. This obstructs the normal functioning of the leaf, preventing the leaf from providing energy to the tree by photosynthesising sunlight. In arabicas, the leaf-tissue slowly dies and the leaf will eventually fall from the tree.

The spores of the fungus are spread by wind, rain and the movement of machines and people. The spores are also present on any old leaves that remain fixed to the tree and on the fallen leaves that have not been cleared from the farm. Spores require moisture to burst into life, or germinate, on the coffee tree. The spread of the disease therefore becomes clearly visible with the on-set of the rainy season. It is common part of La Roya infection cycle that the threat from the fungus appears to have receded as the tree becomes defoliated due to the spread of the disease, the on-set of the dry season and the leaf loss caused by pickers. However, the fungus is present on the remaining old leaves and La Roya once more bursts into life as new leaves begin to develop once the rains return. The development of La Roya on new leaves and the consequent loss of these leaves can potentially be devastating for the next crop as the plant needs this new growth to fix the flowerings- which are also induced by the return of the rainy season.

Wet, humid weather is very favourable for the spread of la Roya- as it is for most fungal diseases. The spread of La Roya is also determined by temperature, with germination favoured in a range of 20-25°C. Temperatures outside this range can slow the spread of La Roya and germination will not



occur if temperatures fall below 15°C. Temperature in the tropics is clearly linked to altitude, so the most severe outbreaks of La Roya have in the past usually been confined to an altitude of 800-900 metres. Outbreaks diminish above this level and the disease is not common above 1,300 metres. Global warming is increasing temperatures in the tropics, so it is very possible that the Zone in which La Roya strikes hardest will migrate to higher altitudes- hitting areas that were previously unaffected by the disease.

The Effects of la Roya on the Coffee Tree

Leaves are the fuel cell of the plant, and the loss of leaves deprives the plant of the energy to perform a whole host of normal functions. The loss of leaves can impact on the current crop as defoliation can disrupt the development of the bean within the cherry causing an increase in the level of defective coffee beans picked during the harvest- damaging the quantity and quality of the crop. *La Roya* can cause the bean to develop as a black bean, or in the extreme case, the cherry may be empty as the bean fails to develop at all. There is also some evidence that the disease may prevent cherries from ripening properly, causing the cherries to go straight from an immature phase to the stage where they fall from the tree, without passing through a red fully ripe period. The beans in these cherries are usually defective, or the cherries are empty.

The physiology of coffee means that the tree remains committed to bringing current crop cherries through to maturity once the flowering has been fixed, no matter what climatic or environmental difficulties are faced by the plant. The tree instead economises on energy, by reducing its investment in the next crop. This means that the branch on-growth, which produces new flowering nodes and buds for the next crop, is reduced as the plant puts its resources into developing the current crop. This can have a drastic impact on crop potential. The impact of carrying a crop with no leaves to support its growth can result in the die-back of the branch (ie: the progressive death of a branch starting at its tip) and in very extreme cases the death of the whole tree. Stumping down the whole tree may well be the only way of renovating a coffee tree which has become very severely affected by La Roya, much as stumping is the only treatment for coffee which has been severely hit by frost.

It is difficult to exactly quantify the damage that can be caused by La Roya in any particular farm. Some studies show that La Roya infestations, defined as less than 20% of old leaves, at low levels causes little output damage in the current year. A rule of thumb often quoted is that a 1% loss of leaves from La Roya causes a 1% loss of output in the following year. A couple of points are clear. The timing of the infestation is important in terms of the damage that occurs. Infestation of the young leaves causes the most serious damage as it can affect the fixing of the flowering for the next crop. It is also the case that the effect on the following crop will be greater, the larger the crop yield in the current year (all other things being equal). A study from the FNC calculates that a farm showing relatively minor La Roya damage of 11-17% of affected leaves 90 days after the flowering will lose 2.7 bags/hect from the next crop, but that this will increase to 4.6 m. bags/hect in the year



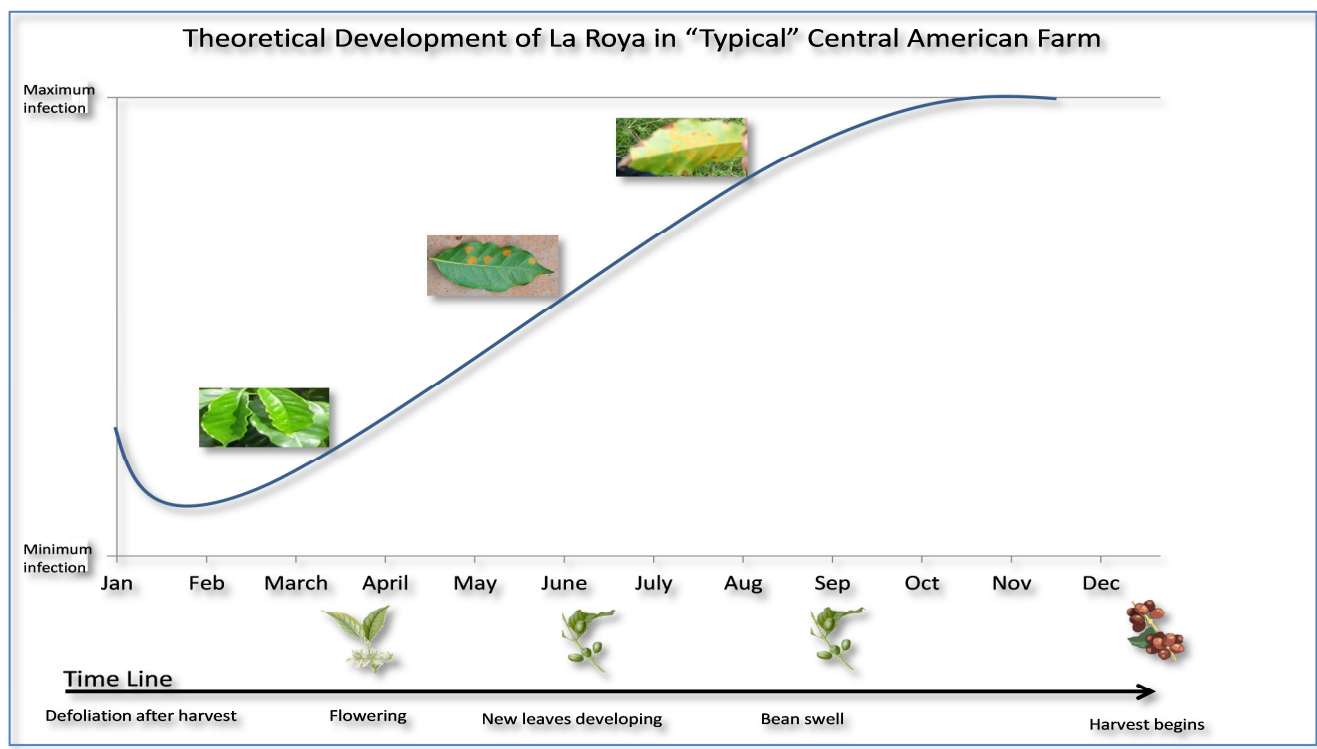
after that. This loss will continue to accumulate if the trees continue to be affected by La Roya. The damage will of course be scaled up if the level of infestation is higher.

The disease will also tend to run in two year cycles, similar to the yield cycles that are a pronounced feature of the arabica plant. *La Roya* will be very active in periods of high yields when the tree has good vegetative growth. The fungus will defoliate the plant in that year, allowing only a sparse leaf growth in the following year. This means that the fungus has less material to infect in the following year, which can allow less severely infected trees to recover in the following year. Unfortunately, unless the tree is treated properly against *La Roya*, the fungus will still be present in the trees waiting to spread more virulently as the leaves begin to develop in the year after that.

Cultural Practices and La Roya

There is an established link between cultural practices on a farm and its vulnerability to La Roya infection, although it can be difficult to disentangle the effect of any single factor due to the complex interactions between the various cultural variables. For instance, La Roya outbreaks are positively associated with high leaf coverage at the start of the rainy season and high yields on a particular farm; however La Roya outbreaks are also negatively associated with good fertilisation. Thus, badly treated farms that get a good crop because of a strong up-cycle, or good climatic factors, are very vulnerable to a La Roya; an outbreak that can be resisted by a healthier, well fertilised tree. Both types of farms benefit if there is a long dry season ahead of the return of the rains, as this will force trees shed leaves which may be harbouring the fungus.

It is a complex subject but to simplify it can be said that (all other things being equal) a well maintained farm, with good husbandry is more resistant to La Roya outbreaks. The textbooks suggest that farmers should clear away the old leaves that have fallen to the ground to prevent





them acting as a source for further infections.

Other points that emerge from the literature are firstly that coffee grown under shade tends to be more vulnerable to La Roya, all other things being equal. The presence of shade trees creates a humid environment within the coffee plantation; they also create low light conditions and act as a buffer to keep the temperature in the plantation within a stable range. These are all factors that help the germination of the La Roya fungus. The interactions of the various factors are again complex, as shade farms also tend to have low yields, which again will help reduce the incidence of rust! Secondly, it has been established that coffee on soils with high acidity are more likely to suffer from La Roya infestations.

Very high-density plantations, (over 5-6,000 trees/hect) also offer good conditions for La Roya to spread. High density planting act like shaded plantations, providing a humid environment with regulated temperature which helps the spread of the fungus. The high leaf density in the plantation also offers a bigger area to be attacked by the fungus. There is also some evidence that high yields and high densities can also cause an increase in soil acidity which can by itself increase the vulnerability of a plantation to attack by La Roya. As a further point, high density also makes it more difficult to treat a La Roya infection once it have broken out on a farm

Chemical Treatments

There are a number of well-established chemical treatments for La Roya. It can be controlled with copper-based fungicides such as copper hydroxide, copper oxychloride and cuprous oxide. These treatments are diluted with water and then sprayed on the leaves, often with a knapsack sprayer. Copper fungicides act by preventing the germination of the fungal spores; they should therefore be applied before the fungal spores have infected the new leaves. There are some problems involved with the use of these fungicides, leaving aside the costs of application. One is the difficulty of timing the spraying application; a delayed application may be too late to prevent the spread of the disease, whilst an earlier application may involve the farmer paying unnecessary costs. Periodic spraying must also continue to protect the flush of new leaves as they develop on the trees.

It can also be difficult to ensure that each leaf receives the correct, economic application of fungicide, stopping the spread of La Roya, and not overusing the product. Finally, strong rains after the application may dilute the product after it has been sprayed on the leaves, reducing the protective impact of the fungicide. Copper can also accumulate in the soil, particularly in the organic matter, and it is possible for it to reach levels toxic to plants and to other organisms.

The difficulties of getting effective protection using copper based fungicides has encouraged the development of systemic chemicals against La Roya, These are mainly based on the triazole group of chemicals that include such branded products as “Verdadero”, “Bayiston”, “Bayfidan and Alto 100. These products work in a completely different fashion from copper fungicides. Systemic products are absorbed by the plant, either through the leaves or the roots, and they then spread naturally through the coffee tree. The absorption of the products provide the tree with a measure of



protection against the parasite, blocking the action of the fungus within the leaves, preventing germination and preventing spores from forming on the leaves. They can be applied by foliar spray, like copper fungicides, and also come in granular form for application to the soil. Systemic products provide a longer term protection against La Roya and also can be used in smaller quantities as they are less likely to be washed away by rains, because they are absorbed by plant. Systemic chemicals are much more effective if used before La Roya spores starts to form on the leaf. They can be used in combination with copper based fungicides if the farm is subject to intense attacks by the fungus.

It can still be tricky to apply systemic chemicals on a schedule that maximises their efficiency in preventing the spread of la Roya. The schedule depends crucially on the crop development within the farm and this can vary sharply from area to area. The schedule for the application can be based on a fixed timetable, or it can vary with the crop development or it can be based on the spread of the disease in the plantation. The FNC recommends applying systemic chemicals 60, 90 and 120 days after the flowering if the La Roya is affecting more than 10% of leaves on the plantation, with a further spraying after 180 days if it affects more than 15% of leaves on a plantation. Alternatively, in areas where the principal crop is in Nov/Dec, it suggests spraying with Alto 100 in May, just after the mitaca harvest as the new leaves start to develop, 30 days later in June, during the branch development phase, and finally 60 days later in August, after the flowering for the Mitaca crop.

Costs of Treatment

The major problem with chemical treatments of La Roya is that they do not come cheap! There is the cost for the chemicals themselves, but also sprayers must be bought and maintained to ensure optimum coverage of the chemicals and labour must be hired to spray the farm. An FNC study (using 2011 prices) puts the cost for each application of Alto 100 (using an ordinary knapsack sprayer) at 249,050 pesos (US\$141)/hectare. Three applications are required normally so the cost of treatment is 747,151 pesos (US\$423)/ hectare per year. The same study puts the cost of treating with granular Verdadero 600 WG at 323,000 pesos (US\$182) /hectare. It is recommended that this product is applied twice a year, so the yearly cost is 646,000 pesos (US\$365)/hectare per year.

These figures need to be put into context against yields and revenue. Average yields per hectare in Colombia are around 10-12 bags/hectare. It should be possible, however, to get over 20 bags/hectare if the farm is treated against La Roya. Therefore, it can be calculated on these FNC figures that the cost of chemical treatment against La Roya can increase Colombian costs of production by around 14-16 cents/lb, based on a yield of 20 bags/hectare. This can also be put into context against the average Colombian internal price in Dec 2012 of 520,000/carga of dried parchment which is equivalent to 138 cents/lb in green coffee terms.

These figures show why farmers may be reluctant to use chemical treatments against La Roya, or attempt to get away with using quantities below the manufacturers recommended standards. It is economical to use chemical treatments in the event of a severe outbreak of La Roya (after all it may be a case of treatment or no crop), but it is a big increase in farmers costs of production. The cost



analysis also explains why scientific institutes researching into coffee have looked to the alternative of breeding plants which have an in-built genetic resistance to La Roya.

Breeding Plants with Resistance to La Roya

The FNC in its response to La Roya epidemic has concentrated on developing plants favourable to the conditions within Colombia, but that have a resistance to attack by the fungus. It was noted above that robusta coffee trees have a natural resistance to attack by La Roya and that the fungus causes little damage in robusta plantations. The strategy has been to cross-breed these immune characteristics of robustas into arabicas. These have mainly been based on Timor hybrids (spontaneous hybrids generated between arabicas and robustas). The first of these hybrids was the Catimor variety, and the FNC then developed Colombia and Castillo resistant varieties which are resistant to La Roya. The Icatu resistant variety has also been developed in Brazil.

This strategy has the advantage that there is, theoretically, no permanent increase to the cost of production once the farmer has shouldered the costs of renovating his farm with a new resistant variety. There are still some problems associated with the plant breeding program. The most obvious is that it is slow and there is large cost in terms of lost production before the new coffee comes on stream. The FNC has more resources and organisational skills than most quasi-governmental organisations involved in coffee. It has still taken a massive effort in Colombia to renovate 445,000 hecs between 2008 (when epidemic of La Roya began) and 2012, equivalent to 47% of the total coffee area. It is also much harder to persuade poorer, smaller farmers to renovate their plantations, the very sector that would most benefit as they cannot afford to pay for chemical treatments.

It is almost impossible to breed a plant that is 100% superior to previous varieties. Breeding for genetic resistance to La Roya, can result in a variety that is inferior in some ways to older varieties. Farmers are by nature conservative, so the “defects” of the new plantings can be amplified by local gossip. Farmers are worried that coffee produced by the new La Roya resistant cultivars have a worse cup profile than that from older varieties or that it may have lower yields, require more fertilisation or different pruning methods.

Breeders of new varieties are also engaged in a continuous “arms race” with the fungal parasite. There are 40 distinct types of the *Hemileia Vastatrix* fungus and genetic mutations of this fungus are also possible in the wild. That means that the fungus can overtime break the resistance of the new arabica cultivars and start infecting the plant with La Roya. A continued process of plant breeding is necessary to keep the disease in check, and also to develop trees suitable to the different areas within each origin.



Lessons from Colombia

La Roya has had a devastating impact on Colombian production when what can only be described as an epidemic of the disease broke out in 2008. The FNC estimates that some 40% of the plantations were infected in 2008. The impact of La Roya accounts for a large part of the annual reduction of Colombian production from 12.6 in the 07/08 coffee year down to an average of 8.4 m. bags over last four coffee years. Parts of the country looked like they had been hit by frost as farmers were forced to stump down coffee as the only curative action as La Roya swept through the plantations. La Roya also led to a downward spiral in production as small farmers were unable to invest in their farms due to crop losses caused by La Roya which in turn meant that the infestation from La Roya (and the subsequent crop losses) was even larger in the following year.

The epidemic was caused by the extraordinary rainfall seen in Colombia from 2008 through to 2011, producing ideal conditions for the spread of the disease. The rain and cloudy weather also caused a reduction in the range between daily maximum and minimum temperatures, further encouraging the germination of the fungus. The unprecedented weather in Colombia enabled La Roya to spread into areas that previously had been unaffected by the disease. The spread of the disease was also encouraged by the high density of planting in many Colombian plantations with many farms planted at 10,000 trees/hectare. FNC recommendations before 2008 were that no treatment against La Roya was necessary in farms above 1,600 metres; the FNC now recommends treatment in farms up to 2,000 metres. The migration of the disease into new areas meant that it appeared in farms where farmers had no experience or knowledge of how to handle the fungus, with the result that the crop losses were even more exaggerated in these plantations. Farmers in desperation often resorted to treatments that were sub-optimal, or even completely ineffective, against the disease.



La Roya affected farm in Colombia



The experience of Colombia does offer some grounds for optimism. Farmers over the last four years have learnt to handle the disease. Farmers have begun to treat with the proper products, because the alternative of not treating probably meant that you would harvest no crop at all. The renovation effort has also borne fruit and farmers have proved themselves willing to experiment with and plant different varieties of coffee. It is now common to find farms in Colombia with planted with mixed cultivars of coffee as farmers commit to renovating a specified percentage of their plantations each year.



Tree in Honduras suffering from severe La Roya infection



Failure of beans to ripen because of La Roya

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