CONILON Coffee

3rd Edition

Updated and expanded

The Coffea canephora produced in Brazil

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'CENTENÁRIA ES8132'
VARIEDADE CLONAL DE MATURAÇÃO TARDIA
Plantio: novembro de 2010
Fazenda Experimental de Bananal do Norte/Incaper
REALIZAÇÃO

10

Clonal Gardens, Seed Production and Conilon Coffee Seedling

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1 INTRODUCTION

For the development of conilon coffee plantations with high productivity and with a final product of differentiated quality, it is important to integrate into the productive process a set of new technologies generated and made available by the research, in a dynamic process that evolves permanently, to the extent that factors which hinder or even limit the effectiveness of the production process are being elucidated and circumvented by the use of new knowledge incorporated into existing production systems. Thus, dynamism, efficacy, competitiveness and longevity are conferred to the activity (FERRÃO, R. et al., 2012). It is this permanent process of innovation that has given prominence to the coffee industry in the scope of the State of Espírito Santo (FONSECA et al., 2012).

The use of propagating material with good quality is a fundamental stage for the implantation of a successful crop, especially in the case of perennial crops such as coffee. Therefore, all genetic material (cuttings, seeds or seedlings) that will work as means of propagation must be acquired from a suitable institution registered by the Ministério da Agricultura, Pecuária e Abastecimento - Mapa (Ministry of Agriculture, Livestock and Supply), which must comply with Normative Instruction 35, of November 29, 2012, which establishes the norms for the production and commercialization of coffee propagating material and its standards aiming at guaranteeing its identity and quality (BRASIL, 2012).

The main product of a breeding program is the development of cultivars. A significant part of the success in the use of an improved cultivar is closely related to the production and availability of seeds and/or quality seedlings. For this, it is of fundamental importance the implantation of good fields of seed production, of seedlings and also the construction and the management of nurseries following the pertinent technical recommendations (FONSECA et al., 2005a, 2005b; FERRÃO, R. et al. , 2012; VERDIN et al., 2014a, 2014b).

Among the main results achieved by the breeding program of the Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural - Incaper (Capixaba Institute for Research, Technical Assistance and Rural Extension), which are used directly by coffee growers, the development and recommendation of eight clonal cultivars and one propagated by seeds are highlighted (BRAGANÇA et al., 1993, 2001; FONSECA, 1999; FERRAO, R.; FONSECA; FERRÃO, M., 1999; FONSECA et al., 2004a, 2004b; FONSECA et al., 2001a, 2001b; FERRÃO, R. et al., 2000a, 2000b, 2015a, 2015b, 2015c; FERRÃO, R.; FERRÃO, M.; FONSECA, 2013; FONSECA, FERRÃO, R.; FERRÃO, M., 2013). BRS Ouro Preto, the first clonal cultivar recommended for cultivation in the producing regions of the northern region of Brazil, was developed and recently launched by the Empresa Brasileira de Pesquisa Agropecuária Rondônia - Embrapa Rondônia (Brazilian Agricultural Research Corporation Rondônia). It was composed of 15 clones, whose propagation is also carried out using cuttings from clonal gardens (RAMALHO et al., 2015).

During the research process to obtain clonal cultivars under experimental conditions, a small number of plants from each of the previously selected clones is used to minimize the volume of resources needed to conduct the field trials. As the genetic materials stand out, additional efforts are made to multiply them, so if their presence in a new cultivar is confirmed later, there will be a minimum number of matrices of each of them, in order to support the launch and to the development of multiplication fields for the later supply of propagating material to nurserymen and others interested in their cultivation (FONSECA, 1996).

The improved conilon coffee cultivars obtained and recommended by Incaper and its partners for cultivation in Espírito Santo have been the main basis for the renewal of conilon plantations in the State, the largest Brazilian producer of the species. It is estimated that in more than 60% of the current coffee-growing area of the state of Espírito Santo, around 160 thousand ha, the technological bases has been renewed, which includes the use of improved cultivars (FERRÃO et al., 2015d). These cultivars are considered by many as the main responsible for the outstanding performance of the new crops, both with respect to productivity and the quality of Capixaba conilon coffee. According to these authors, most of the ongoing crop renovations have been performed with improved clonal cultivars. According to Mauri et al. (2015), in the year 2013 approximately 110 million seedlings of *Coffea canephora* were produced in Brazil, of which only about 10% originated from seeds.

Although in the past there were doubts about the quality of the clonal seedlings, as well as the longevity of the plantations, the mistrust dissipated with the time elapsed since its inclusion in the productive system to the present. Today, it is evidenced that the correct use of asexually propagated cultivars presents competitive advantages over seminal coffee culture, since it provides the faster constitution of the crowns and, consequently, precocity of production. The crops acquire a certain standardization facilitating the accomplishment of the cultural dealings. Thus, it is possible to obtain higher productivity, better uniformity of fruit maturation, greater grain size and uniformity, harvest scheduling and better product quality, among others (ESPINDULA; PARTLLI, 2011; FONSECA et al., 2015).

Plants that originate from vegetative propagation provide an increase in the number of orthotropic buds (PARTELLI, et al., 2006; PARTELLI; AMARAL; VIEIRA, 2011), which, according to Fonseca et al. (2013), provides an increase in the productive capacity of the clonal crops in the first productions. This is due to the fact that the plants are driven from the first production with their crowns consisting of a definitive number of orthotropic stems.

After obtaining, launching and recommending a new clonal cultivar, it is necessary the orderly multiplication of the clones that compose them. To make the seedling production process faster and more effective, Incaper has been using as main strategy the development of clonal gardens in partnership with public and private organizations, such as cooperatives, municipal governments, federal institutes, producers and nurserymen associations (FONSECA et al., 2005a, 2005b; FERRÃO et al., 2012, 2015d).

In this work, the main aspects related to the implantation, development, conduction and correct use of clonal gardens, seed production fields, conduction and nursery management are described, aiming at the production of conilon coffee seedlings.

2 CLONAL GARDENS AND CLONAL SEEDLINGS PRODUCTION

2.1 CLONAL GARDENS

2.1.1 Definitions

Clonal gardens: are fields of conilon coffee matrix plants conducted with the purpose of producing clonal seedlings that make up the clonal cultivars of the species. They are normally associated with nurseries or, otherwise, conducted exclusively with the purpose of producing and passing on cuttings, which are the vegetative structures used for the asexual propagation of the species. The clonal gardens were designed with the purpose of facilitating the faster access of coffee growers to the conilon coffee clonal cultivars recommended by Incaper. They are usually implanted through partnerships involving the Institute and those interested in the production of clonal seedlings.

Clones: are the set of individuals originated from a same plant, through asexual (vegetative) propagation. The plants of a same clone are, therefore, genetically identical to each other and to the one that gave rise to them.

Orthotropic stems: are those that grow vertically, giving support to plagiotropic or productive branches. They are the branches used for the production of clonal seedlings.

Plagiotropic branches: they are those that grow perpendicularly to the orthotropic stems, responsible for the production of fruits in the plants. These branches must be eliminated in the preparation of the cuttings (VERDIN FILHO et al., 2015).

Cuttings: They are the segments removed from the vegetative stems (orthotropic stems), approximately 5.0 cm in length containing a node with two leaves and two plagiotropic branches.

2.1.2 History

Since 1993, several clonal gardens have been installed in the State of Espírito Santo, in most of the municipalities that grow the conilon coffee, in order to support the demand for quality seedlings of the eight improved clonal cultivars and recommended by Incaper: 'Emcapa 8111', 'Emcapa 8121', 'Emcapa 8131', 'Emcapa 8141 - Robustão Capixaba', 'Vitória Incaper 8142', 'Diamante ES8112', 'ES8122 - Jequitibá', 'Centenária ES8132' and 'Marilândia ES8143' (BRAGANÇA et al., 1993, 2001; FERRÃO et al., 2000a, 2000b; FONSECA et al., 2004; FONSECA et al., 2005a, 2005b; FERRÃO, R.; FERRÃO, M.; FONSECA, 2013; FERRÃO et al., 2015a, 2015b, 2015c, 2017). In the partnerships established for the clonal gardens implementation, it is the institution that holds the genetic material the responsibility to transfer seedlings or cuttings and the technical guidelines necessary for the enterprise success. The partner institutions, whether public or private, on the other hand, are responsible for the implementation, conduction and availability or trade of seedlings or cuttings, adopting the distribution policies that best suit them, as long as they follow the pertinent legislation.

The clonal gardens have been of great importance and fully fulfilled their role in the dispersion of superior genetic materials in all the producing regions of the State. They can also be considered as one of the strategies responsible for the expressive evolution of the Capixaba coffee industry, both from the point of view of productivity and quality of the final product (FONSECA et al., 2005a, 2005b).

In the State of Espírito Santo, there are currently 190 clonal gardens located in the main conilon producing regions (Figure 1), together with a production capacity of approximately 50 million seedlings per year, capable of supplying the average demand for necessary clonal seedlings to the annual renewal of about 7 to 8% of the existing coffee area (FERRÃO et al., 2012, 2015d).

In the State of Rondônia, since 2014, fourteen nurseries were accredited by Embrapa Rondônia for the production of clonal seedlings of the Conilon BRS Ouro Preto cultivar. Each nursery received 1.200 matrices (80 of each of the 15 genotypes that compose the cultivar) and with them, they established their respective clonal gardens. Currently, seedlings of the cultivar in question are already being trade in the main coffee producing municipalities of Rondônia.

2.2 INSTALLATION AND CONDUCTION

There are different ways of conducting clonal gardens: the traditional (FONSECA et al., 2005a, 2005b) and the super dense one, carried out in beds or double lines (VOLPI et al., 2017).

2.2.1 Matrices planting

Regardless of the system adopted, traditional or super dense, in the clonal gardens, as the objective is not the production of grains, the plants arrangement of the respective clones of the same cultivar must be made in lines or in plots. In these lines or plots, clones need to be separated and carefully identified (Figure 2), each line or plot must contain a single clone to ensure the control in the production of cuttings, seedlings and subsequent distribution in batches with the respective genetic material (FONSECA et al., 2005a, 2005b; FERRÃO, R. et al., 2012).

Clonal gardens must necessarily have matrices of all the clones that are part of each of the different clonal cultivars recommended by the research. In this way, in the later seedlings trade and crops development all of them can be present in equal proportion. This reduces the risks of narrowing the genetic base and consequent genetic erosion of the species in the country, as well as compromising the agronomic performance of crops.

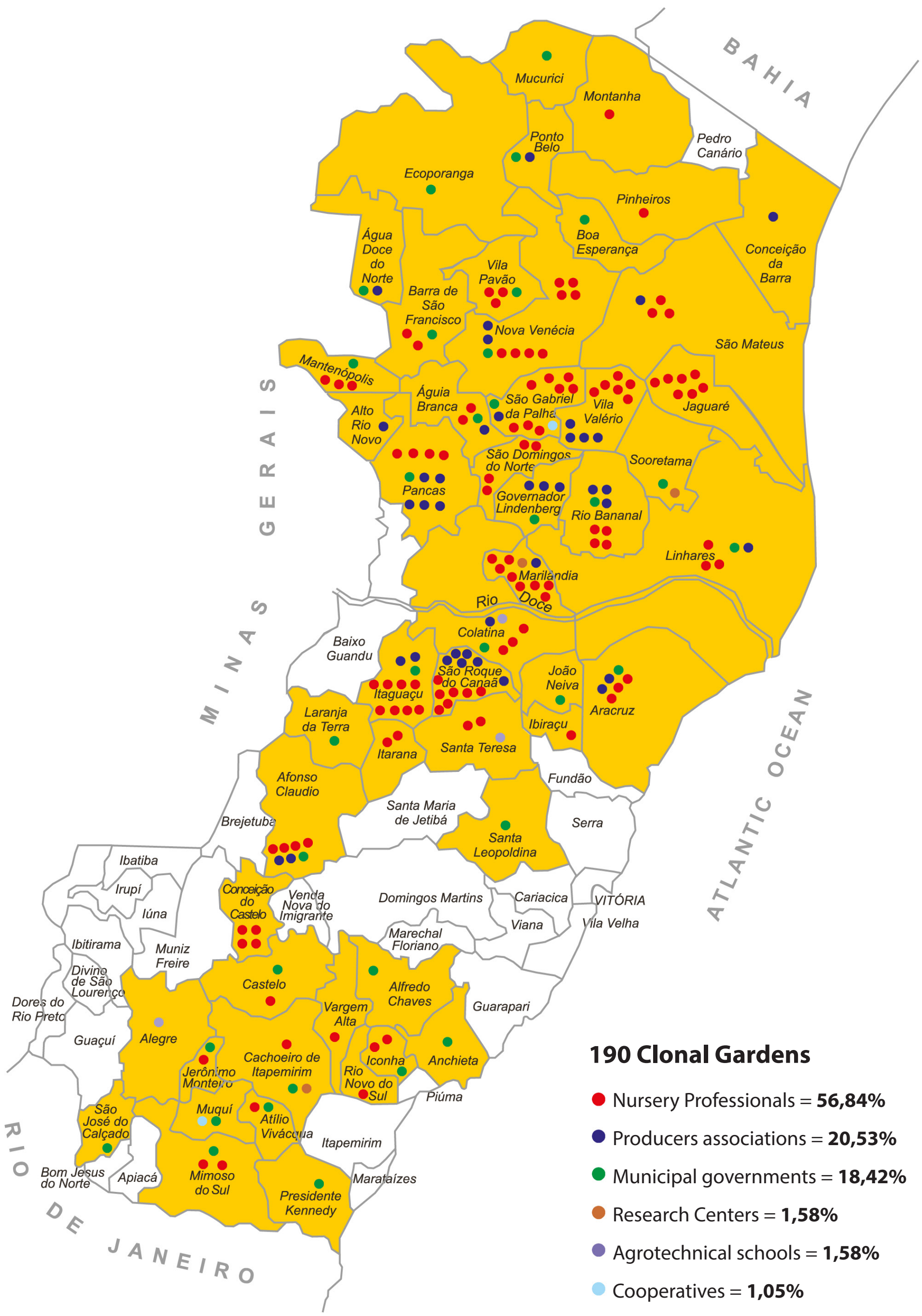

Figure 1. Espírito Santo map with the location of existing clonal gardens in partnership with Incaper.

Source: Adapted from Fonseca et al. (2005a).

This practice contributes to reducing the risk of genetic material elimination that, although not necessarily possess all the valuable attributes of the cultivar, is also fundamental to the announced performance of the respective cultivars as a whole (FONSECA et al., 2013).

The need of cultivating all the clones (genotypes) of the clonal cultivars recommended for their proper behavior is due to the fact that the *C. canephora* species as well as all the other diploid species known in the genus *Coffea*, unlike *Coffea arabica*, self-incompatible.

Figure 2. Clonal garden of the cultivar 'Vitória Incaper 8142' installed at the Experimental Farm Bananal do Norte - Incaper, Cachoeiro de Itapemirim/ ES.

Fonseca (1999) reported a series of studies that demonstrate that the self-incompatibility in *C. canephora* is associated to a single locus, which has an allelic series interacting in a gametophytic system (CONAGIN; MENDES, 1961, BERTHAUD 1980; LASHERMES et al., 1996; FERRÃO et al., 2015d). This photo conditions the need to grow different genotypes (clones) in the same area. This occurs not to have pollination and cross fertilization restriction between them (FONSECA et al., 2005a, 2005b; MAURI et al., 2015). Moreover, for this reason, in addition to those previously mentioned, one should not, whatever the hypothesis, produce or acquire seedlings of any clonal cultivar that is incomplete or in different proportions (FERRÃO, M. et al., 2012; FONSECA; FERRÃO, M.; FERRÃO, R., 2013).

It is essential that in the acquisition of seedlings in commercial nurseries duly registered in the Ministério da Agricultura, Pecuária e Abastecimento - Mapa (Ministry of Agriculture, Livestock and Supply), it is mandatory to prove that the cultivar acquired is composed of all the clones as recommended. It is known that all of them have an important role to play in the composition of each clonal cultivar, and that the announced performance can only be ensured under conditions of the cultivars integrity (FERRÃO, R.; FONSECA; FERRÃO, M., 1999; FERRÃO et al., 1999; FONSECA et al., 2005a, 2005b; FERRÃO, R.; FERRÃO, M.; FONSECA, 2013; FERRÃO et al., 2015d; MAURI et al., 2015).

The schemes for planting clonal gardens are shown in Figure 3 (in planting in single lines of each clone) and Figure 4 (plots of the same clone), since in these cases the objective is only the production of cuttings, not grains, without the necessity of proximity between the different clones.

In the establishment of clonal gardens in the super dense system, the plants of the same clone must be planted in double lines with matrices arranged in a disjointed way to facilitate the matrices handling, especially at the time of the stems extraction, reducing the possibility of mixtures of the cuttings (VOLPI et al., 2017). In Figure 5 there is a scheme illustrating some details for the implantation of super dense clonal gardens.

The planting must be done in grooves or in pits with dimensions of at least 0.4 x 0.4 x 0.4 m, being the procedures of soil corrections and fertilization as well as the other care, the same necessary for the implantation of crops for grain production (FERRÃO et al., 2012). In these cases, however, more attention is needed to nutrients replenishment, given the plants high demand for the constant removal of their vegetative structure parts.

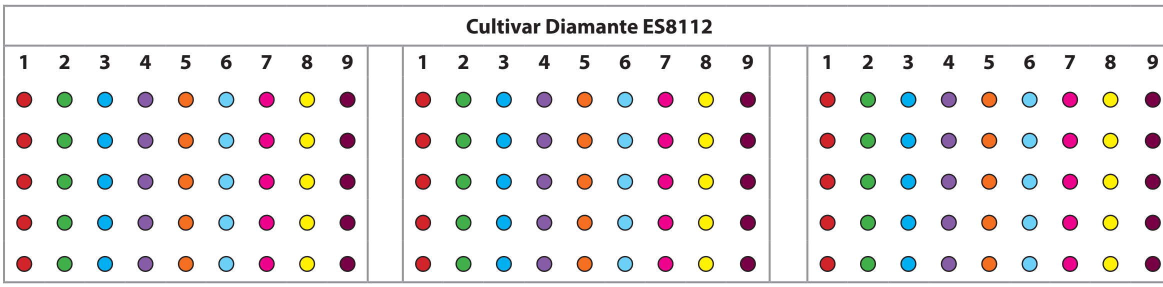

Figure 3. Scheme for the establishment of clonal garden with the cultivar Diamante ES8112, with its respective clones arranged in individual lines, in three successive fields.

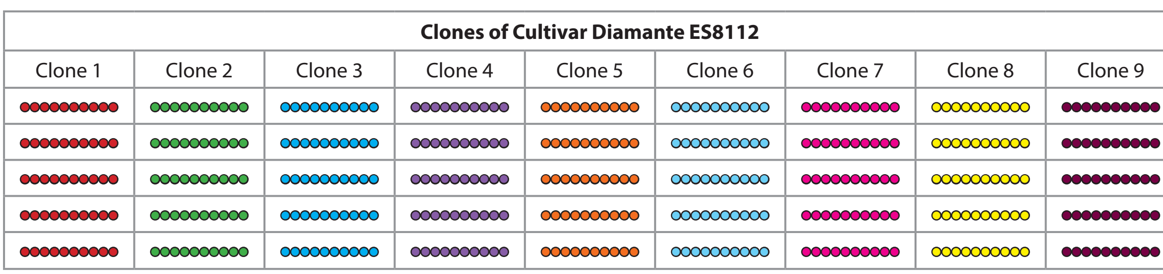

Figure 4. Scheme for the establishment of clonal garden with the cultivar Diamante ES8112, with their respective clones arranged in plots.

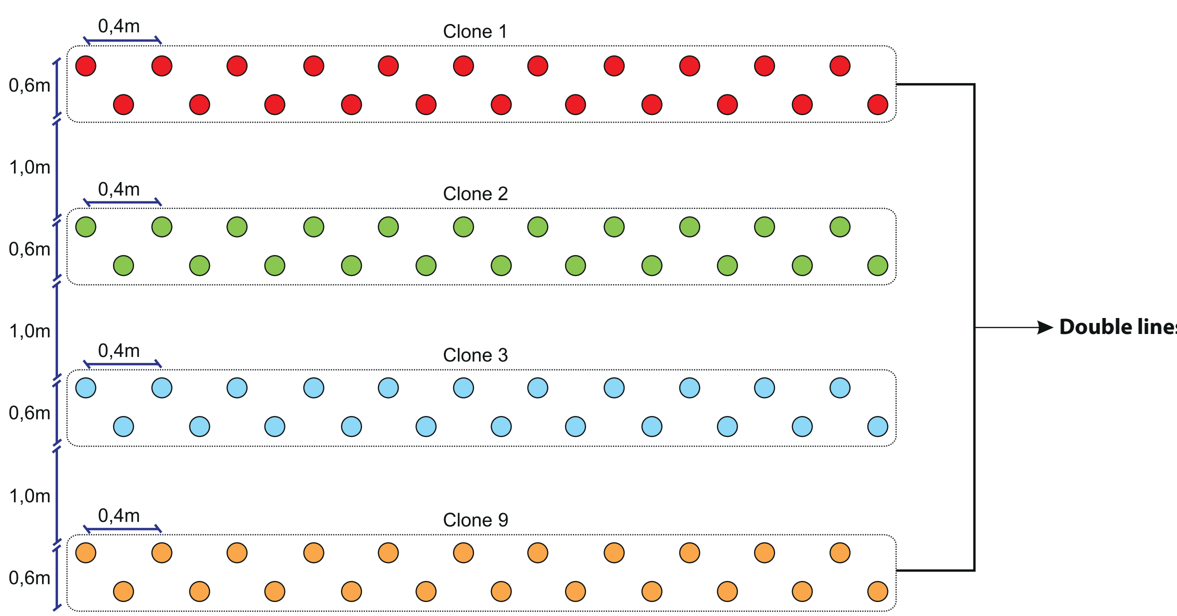

Figure 5. Scheme for the implantation of a super dense clonal garden with the cultivar Diamante ES8112, composed of the grouping of nine clones.

Source: Volpi et al. (2017)

2.2.2 Spacing and preparation of matrices

Conducted in the traditional system, the plants must be arranged with smaller spacing than when the goal is the grain production. Spacing of the order of 2.0 x 1.0 m, totaling 5 thousand plants/ha, have been the most employed so far. In this system, when the orthotropic stems are about two years old or more, 1.5 m high, the procedures for preparing the matrices for the emission of abundant shoots can be initiated (FONSECA et al., 2005a, 2005b; MAURI et al., 2015).

The production of cuttings from adult matrices can be initiated by the matrices preparation by making the orthotropic rods bend (Figure 6A) or by opting for high recepa of several of these rods (Figure 6B). The rods bending can be achieved by attaching its end to the ground with the help of bamboo forks or other resource, and in the case of high recepa, cutting at a height of about 1.2 m. In both situations, the objective is to give the plant a "cup" aspect, increasing the exposure of the vegetative buds to the sun and competing for more numerous development of vigorous buds, as shown in Figure 7. When the buds have between four and eight pairs of leaves, they must be detached from the mother plant to give rise to the cuttings (FONSECA et al., 2005a, 2005b; MAURI et al., 2015).

By opting for high recepa, it is not advisable that it be carried out on all stems at the same time, as this would cause the death of a large part of the active root system, delaying the development of buds and the aerial part recovery. In the mother plants, at least one of its stems must be kept intact, which will act as a "lung" until the buds develop normally, according to Figure 8 (MAURI et al., 2015).

Denser spacing (1.0 x 1.0 m), with the younger plants bending, can also be used to get faster precocity in obtaining cuttings. This form of conduction, however, demands a significantly more intensive and complex management of the clonal garden (MAURI et al., 2015) and may compromise both the total cutting production and the matrices longevity (Figure 9). However, it is more recommended the use of super dense clonal gardens, as they can economically reward the additional costs of required handling operations.

When using the super dense clonal gardens system, with the planting done in double lines, the spacing is then further reduced to obtain a higher density of rods and ease of operations within the area. In these cases, spacing of the order of 0.4 m between plants, 0.6 m between planting lines and 1.0 m between the double lines have been successfully used, either in raised beds or conducted in the open field, providing a population of approximately 31,250 plants/ha (Figures 10, 11 and 12).

The densification of the matrices may favor its precocious depletion, but this fact can be compensated by allowing greater precocity in obtaining cuttings and the faster economic return provided. It is even more noticeable when it comes to genetic materials still very restricted by the high value of cuttings and seedlings of new improved cultivars, which are always very demanded by the coffee growers.

Figure 6. Bending matrices (A), and partially cut (B) for the emission of numerous vegetative buds stimulation.

Figure 7. Matrices of numerous sprouts by exposing the vegetative buds to the sun.

Figure 8. Partially cut matrix displaying buddings suitable for the production of cuttings.

Figure 9. One year old matrices being used for the production of cuttings.

Figure 10. Aspects of the clonal garden super dense with the cultivar Diamante ES8112, conducted at the Incaper Experimental Farm in Marilândia/ES.

Source: Volpi et al. (2017).

Figure 11. Super dense clonal garden conducted in one of the Demonstration Units on Bela Vista Farm owned by Mr. Carlos Roberto Gomes Cândido in the municipality of Sooretama, ES.

Figure 12. Super dense clonal garden conducted at one of the Demonstration Units on Volta Grande Farm owned by Mr. Adelson Rossmann, Laranja da Terra, ES.

2.2.3 Fertilization

The fertilization of implantation and development of the clonal gardens should be carried out according to the recommendations of Costa and Bragança (1996), Bragança, Lani and De Muner (2001), De Muner et al. (2000, 2002), Lani, Prezotti and Bragança (2007) and Guarçoni M. (2011). There is a need for constant monitoring of nutrient content in soil and leaves so that there are no nutritional limitations that prevent the maximum production of stems to be used in the seedlings production. In addition to maximizing the production of cuttings, the matrices adequate nutrition is important for the maintenance of the reserves necessary for the budding and the reinvigoration of the root system, which is very required in these conditions. According to Mauri et al. (2015), nitrogen fertilization in clonal gardens has been commonly increased by 25% of the doses recommended for cultivation, and with the other nutrients following the same criteria used in the conduction of crops for production.

2.2.4 Irrigation

It is an extremely important practice in the conduction of clonal gardens. It must be performed according to the criteria recommended for the crop in each region considering the demand of the species and the different local climatic conditions. It is essential that there is no shortage of water supply, as well as adequate distribution throughout the entire seedling production period, in order to achieve the expected results both in terms of the number of cuttings per matrix and the longevity of clonal gardens.

The irrigation system to be used depends on, among other factors, the quantity and quality of the water available and, naturally, the availability of resources for investment.

In super dense systems, irrigation can be done using fixed low flow spray, micro sprinkler or even localized irrigation. It must be carried out considering evapotranspiration at each time of the year and the crop coefficient, and from there, the amount of water to be supplied in each application and the corresponding irrigation turn is calculated. In general, the irrigation is performed two to three weekly, identical to the initial development handling of conventional planting.

2.2.5 Removal and preparation of stems originating from orthotropic or vertical buddings

The stems used for the production of clonal seedlings are the still very young orthotropic ones, those that grow vertically in the plant (Figure 13). They must be selected, detached and transported (Figure 14) as soon as possible to the vicinity of the nurseries in fresh, sun protected locations where the cutting process should begin. The stems collected from each clone should be prepared by well trained teams, seeking to eliminate the possibility of mixtures (Figure 15). For the same reason, it is also necessary to work with one clone at a time, until planting in the nursery and in different and properly identified beds (Figure 16).

Figure 13. Matrix with vigorous budding, ready for the removal of new stems for the production of cuttings.

Figure 14. Buds detached form the matrix to be conducted near the nurseries.

Figure 15. Buds being prepared for the individualization of cuttings at the Incaper Experimental Farm in Marilândia/ES.

Figure 16. Individual beds identified and each containing a single clone.

2.2.6 Preparation of cuttings for planting

After the removal of the orthotropic stems, their ends are eliminated, since the basal parts are normally already in the lignification process, and the apical parts still contain little reserve and are more sensitive to water loss (Figure 17). Of the useful part, usually between three and six nodes are used. Each must have the both leaves and two productive or plagiotropic branches. The productive branches are then removed by cutting them with a pruning shear about 1.0 cm from the insertion in the vertical stems (Figure 18). Then, one third of the leaves are cut with the aid of a pair of scissors so that there is no mutual shading (Figure 19).

Figure 17. Removal of the ends of the stems eliminating the most basal ones and the pointers.

Figure 18. Elimination of the plagiotropic or productive branches of the stems.

Figure 19. Elimination of part of the leaves.

With the stems thus prepared, the cuttings are then individualized and cut about 1.0 cm above the insertion of the plagiotropic branches and 3.0 to 4.0 cm below the leaf insert (Figure 20).

Until recently, it was recommended that the lower part of the cutting be bevel cut (FONSECA et al., 2005b), for inducing the faster emission of the first roots (Figure 21). However, in a recent work carried out by Verdin Filho et al. (2014a), in which they studied in more detail the influence of the type of cut in the inferior part of the cuttings, it was verified that the cut must be straight. According to the authors, this type of cut promotes greater total biomass production, better distribution of roots around the trunk and better final quality of the seedlings, when compared to the bevel cut (Figure 22).

According to Verdin Filho et al. (2014b), it is recommended that the cuttings be separated according to the parts of the branch which have been removed, which should be planted in different beds and batches. This grouping is fundamental to obtain more homogeneous batches with less need to place the more similar ones in different beds (Figure 23), since the cuttings of each portion have different amounts of reserves, tending to develop with different patterns. According to the same authors, the cuttings of the medial portion of the orthotropic stems stand out in the production of seedlings with greater growth of the aerial part and the root system.

The cuttings should receive phytosanitary treatment according to the recommendations of the technician responsible for the nursery to avoid the occurrence and spread of diseases. Thus, already prepared and ready for planting, the cuttings should be taken to the nursery and planted in the shortest possible time (Figure 24).

Figure 20. Stem aspect after the removal of the productive branches and part of the leaves.

Figure 21. Aspects of the cuttings individualization (A), the bevel cut at its lower end (B) and the uneven growth of the roots of the cutting end thus prepared (C).

Photo: Figure 21C, (VERDIN FILHO et al., 2014a).

Figure 22. Details of little cutting (A) and root distribution when cuttings are subjected to straight cuts at both ends (B).

Photo: Figure 22B, (VERDIN FILHO et al., 2014a).

2.2.7 Production of cuttings by matrix

In the traditional system of clonal gardens conduction, usually after two years old the matrix is adequately developed and this is the ideal condition for it to be prepared to start the cutting process. Each matrix can reach the production of up to 200 cuttings in each cut totaling 300 to 400 cuttings per year, since although it is possible to make two cuts in a year, there is usually a slow growth of buds in the colder period (FONSECA et al., 2005a, 2005b).

In order to reach the production of cuttings earlier and in a more abundant and economical way, the super dense clonal garden has already been used. Comparing the traditional system of clonal garden development with the super dense one, the authors showed significant advantages of this new alternative, noting that while the traditional system provides the first extraction of cuttings with about 36 months (if the matrix preparation was started at 24 months), the new system, conducted in full sun, allowed the first extraction to occur seven months after planting (Figure 25).

Figure 23. Seedlings need to be re-raised due to the difference in vigor between the cuttings in the planting.

Figure 24. Aspects of cuttings planting in bags distributed in duly identified beds.

According to Volpi et al (2017), the super dense system provides more than 500 thousand cuttings/ha in the first extraction, at seven months old (Figure 26), and that at 24 months old, when the matrices preparation for the production of cuttings in the traditional system, more than 4.3 million cuttings would have been produced in the new system. This fact, therefore, characterizes a significant advantage over the first system, both for the quantity produced and for the precocious obtainment of the propagation structures. According to the authors, after 36 months of planting, the cuttings production in the traditional system can provide 1.5 to 2.0 million cuttings per hectare, while in the same period it can reach more than 7.0 million cuttings in the super dense system.

2.2.8 Acquisition of genetic material in clonal gardens

The genetic material of vegetatively propagated cultivars for the development of clonal gardens must be acquired from an appropriate institution, registered by Mapa.

Figure 25. Implantation of a super dense clonal garden with a shading cover of 50% shadow, recently planted and already bent (A and B) and without cover (C).

Figure 26. Matrices aspect with seven months after the planting in super dense clonal garden.

In the case of the clonal varieties developed by Incaper's breeding program, the orders of material for the clonal gardens development should be sent to Incaper's (by telephone: (55) 27 3636-9888 or directly to the headquarter of the Institute: Rua Afonso Sarlo, 160, Bento Ferreira, CEP: 29052-010 - Vitória, ES, Brasil.

3 SEED PRODUCTION

Due to many coffee plantations are still formed from seedlings that come from seeds, there is a need to produce good, physiological, physical, genetic and sanitary quality material when produced. Seedlings originated from good quality seeds are more vigorous, are more likely to resist when planted in the field and will produce plants with better development and sanity.

Currently, there are three *C. canephora* cultivars registered in Mapa that can be propagated through seeds, that is, through seminal pathway. They are: 'Conilon', 'Emcaper 8151 - Robusta Tropical' and 'Apoatã - IAC 2258'.

C. canephora cultivars, notably 'Apoatã - IAC 2258', have been used as rootstock for the production of seedlings destined to the impalntation of crops in areas with nematodes as they have high resistance to the nematode *Meloidogyne exigua* and tolerance to *Meloidogyne incognita* (FAZUOLI; LORDELLO, 1977; FAZUOLI; COSTA; FERNANDES, 1983).

The seeds of the cultivar Emcaper 8151 Robusta Tropical are obtained by recombining 53 elite clones of the Incaper conilon coffee breeding program (FERRÃO et al., 2000a, 2000b). This cultivar can only be obtained by planting all these clones together and in an isolated place for controlled pollination between them.

In Table 1, the production and marketing patterns of *C. canephora* seeds can be verified, according to IN 35 specifications, Mapa (BRASIL, 2012).

Table 1. *Coffea canephora* seed production and marketing patterns.

Parameters	Patterns
Pure seed (% minimum)	98
Determination of other seeds by number (maximum number):	
- Seeds of other species	2
- Wild seeds	2
- Harmful seed tolerated	2
- Harmful seed forbidden	Zero
Infested seeds (% maximum)	3
Seed with live coffee berry borer (*Hypothenemus hampei*) (% maximum)	Zero
Germination or viability (% minimum)	60
Validity of germination or viability test (maximum in months)	2
Validity of the reanalysis of the germination or viability test (maximum in months)	1

Source: Adapted from Brasil (2012).

Conilon coffee seeds show slow and uneven germination both in laboratory and field conditions, with the aggravation of rapidly losing the germination potential during storage. Thus, due to the difficulty of storing these seeds, sowing to obtain seedlings should be carried out as soon as possible after harvesting and preparation (DIAS; BARROS, 1993). Allowing *C. canephora* seeds to not lose viability during the storage has been one of the main challenges of research in this area.

The conilon coffee, when propagated by seeds, present variations as to their architecture, productivity, resistance to diseases and pests, fruit maturation time, seeds size and shape, fruits and leaves (BRAGANÇA et al., 2001).

3.1 OBTAINING SEEDS

The seeds must, preferably, be obtained from research institutions or crops of producers previously registered and accredited in Mapa for this purpose. Because it is a cross-fertilization species, the care is necessary to ensure that the seeds are collected in a balanced manner in the matrices, whose seeds, properly mixed, correspond to the seeds of the cultivar in question in order to guarantee their genetic variability as is the case of 'Robusta Tropical - Emcapa 8151' (FERRÃO et al., 1999b, 2000b, 2015d).

The seeds should be collected in vigorous, healthy and high load plants, when they are in complete physiological maturation, when they accumulate the maximum possible dry matter and vigor, which gives them greater viability (PADILHA; CARVALHO; EIRA, 2008). According to Alves (2008), in general, the stage of physiological maturation is easily identified by the change of the fruits coloration of "cane green" to "ripe cherry" (Figure 27).

After harvesting, which should preferably be done manually, the fruits should be immediately processed so that the quality of the seeds is not affected (SILVA et al., 2010). The seeds must be submitted to the processing, which consists of depulping, degumming and drying, before being sown or stored (TOMAZ et al., 2012).

Figure 27. Harvesting of ripe fruits for the production of seeds.

Photo: Daniel Simões.

3.2 DEPULPING AND DEGUMMING

Once harvested, the ripe fruits are submitted to mechanical depulping to remove the exocarp, and then the seeds are subjected to degumming to remove excess mucilage (mesocarp) adhered to the parchment. The mucilage removal can be accomplished by natural fermentation, mechanical and chemical processes or by the combination of methods. Degumming is necessary, since mucilage residues are rich in carbohydrates and constitute a suitable substrate for the development of microorganisms (PEREIRA; VILLELA; ANDRADE, 2002; PADILHA; CARVALHO; EIRA, 2008).

Degumming by natural fermentation is the most indicated. It is a simple and efficient process for the production of good quality seeds (PEREIRA; VILLELA; ANDRADE, 2002; PADILHA; CARVALHO; EIRA, 2008). This process can be performed in masonry tanks with water for a period of 12 to 24 hours (ALVES, 2008), and according to the same author, the mesocarp of *C. canephora* is less watery and less sweet than in species *C. arabica*.

After degumming, the seeds should be washed in running water for complete mucilage removal (PADILHA; CARVALHO; EIRA, 2008) and then placed in trays with a screened bottom to drain water excess.

Then, the seeds are separated manually by removing depulped fruits (coconut coffee), epicarp (bark) and endocarp (parchment) residues, smaller seeds and broken seeds. Giomo, Razera and Gallo (2002) recommend the treatment in air machine and sieve and gravitational table, suggesting that small and light seeds are discarded from the lot for presenting low physiological quality.

3.3 DRYING AND STORAGE

After the extraction and cleaning processes, the seeds should be dried in the shade or forced air circulation oven at 30 ºC. The minimum criteria for the production and marketing of conilon coffee propagating material, according to Ordinance No. 338 of November 30, 2010 (BRASIL, 2010), determine that the minimum acceptable moisture content is 15% and that the packaging must be made in packages that allow its aeration, such as jute bag, braided polypropylene and multifolium paper.

The definition of the ideal conditions for drying and storage of coffee seeds is fundamental for the maintenance of the viability of the seeds during this process, and for conilon coffee, further studies are necessary. Providing conditions so that *C. canephora* seeds do not lose viability during storage has been one of the main challenges of the research in this area. For this purpose, the moisture content of the seeds, packaging, temperature and storage time should be considered (VIEIRA et al., 2007).

According to Dias and Barros (1993), conilon coffee seeds exhibit slow and uneven germination, and rapidly lose their germination capacity during the storage process. This fact obliges sowing to be carried out right after harvesting, concentrating the seedlings acquisition at times that are not always suitable for planting (ARAUJO et al., 2008). As coffee seeds are very sensitive to dehydration, this has been considered the main cause of the rapid loss of germination during storage (ELLIS; HONG; ROBERT, 1990).

Several studies have been carried out to evaluate the seeds longevity during storage, with variable results depending on the cultivar, seed moisture, packaging and environmental temperature. However, the results still do not allow to define an efficient procedure of drying and storage of conilon coffee seeds, mainly due to the great variation in the evaluated conditions.

Hong and Ellis (1995) observed similar behavior in the seeds of *C. canephora* and *C. arabica* during storage, both showing intermediate behavior in relation to orthodox and recalcitrant seeds.

Favorable results were found by Andreolli, Groth and Razera (1993), when they obtained 83% germination after seven months of storage of *C. canephora* cv seeds. Guarani, with 35% humidity, in polyethylene packaging. Similarly, Fazuoli et al. (2002), evaluating the *C. canephora* cv. Apoatã seeds, found that the germination was maintained at 70% after 10 months of storage when packed with 34% moisture in a polyethylene package at temperatures of 10 to 16 ºC.

Andreolli, Groth and Razera (1993) also obtained favorable results for the conservation of *C. canephora* seeds, when stored at 20 ºC in a saturated atmosphere, with high relative humidity reaching 80% germination after 9 months. However, Brandão Júnior (2000) verified a total loss of *C. canephora* seed germination after six months of storage in a cold chamber, while in the environment with a relative humidity of 80% and a temperature of 20 ºC, seeds with 41% moisture maintained the physiological quality. According to Van Der Vossen (1979), coffee seeds are preserved for up to two and a half years when packed in polyethylene bags and moisture content of 41% at 15 °C.

According to Oliveira et al. (2004), the seeds of *C. canephora* cv. Apoatã IAC-2258 storage at 10 °C was harmful to the physiological quality, even when the seeds were with a high degree of initial moisture (41%). However, Rosa et al. (2005) verified that the seeds of this same cultivar can be stored for up to four months at a temperature of 10 °C if the water content is 15%.

For arabica coffee, several studies have indicated that, in general, their seeds are better conserved when stored with relatively high humidity, around 35% (VASCONCELOS; GROTH; RAZERA, 1992) a 40% (BARBOSA; HERRERA, 1990).

Another factor that has contributed to the viability loss of coffee seeds is contamination. According to Squarezi et al. (2002), cited by Ribeiro et al. (2005), the reduction of viability is due to the advance in the deterioration process, which, in turn, occurs mainly due to the high incidence of fungi. In studies with robusta coffee seeds (*C. canephora* Pierre ex Froehner) during storage, Braccini et al. (1998) isolated and identified five different genres of fungi infesting the robusta coffee seeds: *Fusarium semitectum*, *Colletotrichum* spp., Alternaria spp., *Aspergillus* spp. and *Penicillium* spp.

It is possible to purge seeds for the coffee berry borer (*Hypothenemus hampei*) and the coffee bean weevil (*Araecerus fasciculatus*) control. For the purging, it has been common to use aluminum phosphide in tablets applied to seeds covered under plastic canvas according to the manufacturer's recommendation (BRACCINI et al., 1998).

3.4 DORMANCY OVERCOMING

The mechanism responsible for coffee seed dormancy is not yet completely elucidated, which can be caused by mechanical impediment to water entry or restriction to the development of the embryo.

According to Guimarães and Mendes (1997), the germination of coffee seeds is, in general, slow and uneven. This fact can be attributed to the parchment, a leathery and resistant wrap (endocarp).

Removal of the parchment may be useful to accelerate the germination process of coffee seeds. This process can be carried out manually, more laborious and time consuming, or by seeds immersion for three hours in sodium hypochlorite solution with 6% chlorine (RUBIM et al., 2010).

4 NURSERIES FOR SEEDLING PRODUCTION

Conilon coffee seedlings can be formed via seeds (sexually) or through vegetative parts, such as cuttings (asexually). In any case, propagation material should come from selected, productive, healthy matrices with superior agronomic characteristics and, above all, recommended genetic material, properly registered for the regions in which the seedlings will be used.

Nurseries for the coffee seedlings production have the objective of meeting the internal demand of the property or for marketing purposes, presenting a great variety of physical structure and seedling production capacity, both in quantity and quality. The choice of the most appropriate type, for each situation, depends on the nursery purpose, whether commercial or own use; the most readily available material on site; the desired length for the seedlings production; and the knowledge and technological level of the producer or the nurserymen (MATIELLO, 1998; MATIELLO et al., 2005).

4.1 NURSERY CONSTRUCTION

For production of seedlings propagated by seeds, the nursery may be constructed of more rustic materials, available on the property, such as wooden or bamboo slats; may be covered with materials such as palm leaves, elephant grass or any other that provides a similar effect.

Nurseries should be constructed with the cover facing north-south direction, following the technical specifications. The beds should be between 1.0 and 1.2 m wide and variable length, separated by corridors of 0.6 m wide (Figure 28), to facilitate the passage of people, crop treatment and seedlings transportation. The external pathways must have width compatible with the movement of the vehicles used (De MUNER et al., 2000).

For the production of clonal seedlings, the nurseries may present different characteristics, depending on the purpose with which it is conducted (FONSECA et al., 2005b). In any case, it requires about 50% to 70% of shading in the rooting period (BRAUN et al., 2007). It requires automated irrigation to maintain substrate and air humidity, thus avoiding excessive water loss through transpiration. In this way, clonal seedlings are produced, in almost all cases, in nurseries covered by shading material (sombrite) and with micro sprinkler irrigation system (ESPINDULA; PARTELLI, 2011).

Figure 28. Dimensions of beds and nursery circulation areas.

The commercials, usually capable of producing large quantities of seedlings, are generally constructed of more durable materials and, almost always, are better equipped, aiming at the care required by the propagating material. They should be covered with shading material (sombrite) for the 50% reduction of incident radiation. The sides must be protected with transparent plastic canvas for the maintenance of higher temperature and relative humidity inside. These factors may contribute to the increase of the cuttings index use and to the reduction of the time necessary for the seedlings production, as shown in Figure 29.

Despite the required care, the clonal seedlings production can also be carried out by the coffee growers themselves, even in small properties, using more rustic and low cost structures. In such cases, as described by Silveira and Fonseca (1995), conventional nurseries can be used, with the cuttings planted under covers or tunnels of transparent plastic material, placed inside the nursery, in which containers are kept with water to favor maintenance of high relative humidity (Figure 30).

Figure 29. Coverage aspects and lateral protection of nursery.

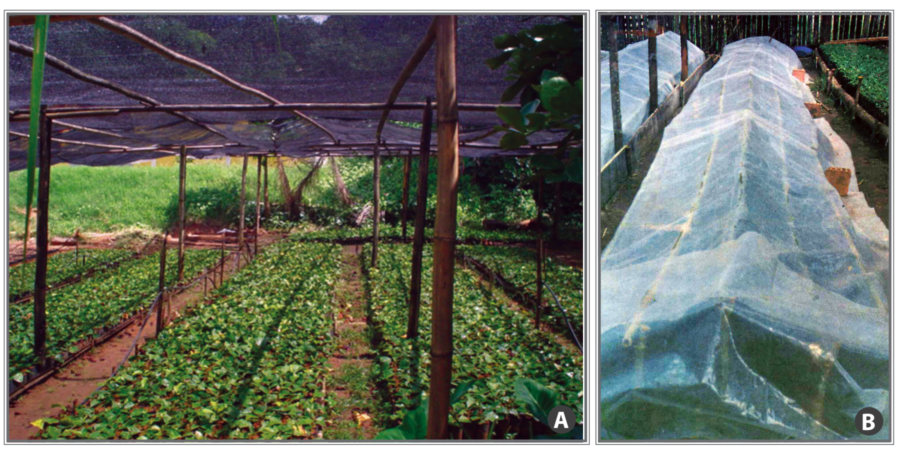

Figure 30. Rustic nursery for the seedlings production, built with materials from the farm itself (A); and tunnels to produce clonal seedlings in small quantities (B).

4.2 NURSERY LOCATION

The nurseries should be constructed in places of easy access, with little difference to facilitate the flow of water excess. They should also have water availability of good quality and easy irrigation, protected from wind currents and floods and weed-free, mainly coco-grass and silk grass (De MUNER et al., 2000).

When the nursery is intended for the production of seedlings for commercialization, its proximity to the consumer market should be analyzed. In order to facilitate the seedlings delivery and transportation, the traffic of animals and people must be avoided in order not to spread weeds, pests and diseases. In the case of clonal seedlings production, the nursery should be installed near the clonal garden.

The area to be occupied will depend on the number of seedlings to be produced and the size of the container used, be it bags or tubes. In general, in each square meter of bed, between 180 and 200 of seedling bags are accommodated, depending on the size of the bags used. In the case of the use of tubes with a capacity of 280 ml of substrate, the trays, placed directly on the ground, support 207 tubes/m^2; while for flat suspended trays, 218 tubes/m^2.

4.3 BEDS PREPARATION

The conilon coffee seedling production should be done by sowing or planting the cuttings directly in the containers previously filled with the substrate and arranged in beds. It is not recommended to use pre-germinators or beds with sand beds in order to avoid bifurcation and bad distribution of the seedlings root system, both those propagated by seeds and by cuttings.

The containers in which the sown or the cutting will be done, can be arranged in beds, directly on the ground, or suspended, supported by wooden structures, metal sheet angles or by reticulated grid wire.

In the soil, the beds can be covered with sand and appropriate blankets are placed on it, in order to facilitate the drainage of excess water and prevent the growth of invasive plants.

In the case of suspended beds, although there is an additional cost, it is easier to carry out the culture treatments, besides being more efficient in controlling invasive plants, pests and diseases. In these cases, they are made at an average height of 0.9 m from the ground. In this system, the containers, more commonly the tubes, are placed in trays or screens, where they are fitted. The tubes are generally supported by structures that hold them suspended so that the roots do not grow beyond the container's boundaries, preventing them from becoming tangled.

Rooting beds may also be used, but it is not a commonly recommended practice since conilon coffee has excellent rooting ability. However, some clones may present low rhizogenesis capacity, being, in these cases, the cutting in special beds is a necessary practice.

The greenhouse system is not suitable for hot regions, as this type of cover can generate excessive heating. The system is recommended, especially when cutting is carried out in cold regions and/or periods. The residence time in the rooting bed will vary according to the rhizogenesis ability of the clones. Cuttings must be monitored and when the rooting occurs, the transplanting is carried out to the definitive container.

4.4 CONTAINERS

Coffee seedlings can be produced in opaque polyethylene bags, equipped with drain holes or tube type containers. The polyethylene bags are still the most used for the production of conilon coffee seedlings, either for the production of seedlings or clonal seedlings. The size of the containers may range from 9.0 to 11.0 cm in width and 18.0 to 20.0 cm in length for seedlings and 11.0 to 20.0 cm in width and 21.0 cm in length for clonal seedlings. They must have at least 30 perforations from the lower half of the container to the basal part to facilitate the drainage of excess water.

The production of coffee seedlings using a tube as a container provides a reduction in the need for labor, optimization of culture practices and facilitates the transportation logistics of the seedlings.

For the seedling production from seed, good results have been obtained (MARANA et al., 2008; BRAUN et al., 2009). However, in the production of clonal seedlings, studies are still few. Ronchi and DaMatta (2007) report a negative effect of seedling production on seedlings, especially if the seedlings remain for long periods in small containers. However, in many nurseries vigorous clonal buds with a well-formed root system are obtained using larger tubules (approximately 280 cm 3). Despite the relative success obtained in these nurseries, the use of tubes for the production of conilon coffee clonal seedlings still needs to be studied for some important details, such as container capacity and shape, plant nutrition, nursery management, among others.

4.5 SUBSTRATE FOR THE PRODUCTION OF SEEDLINGS

In the production of conilon coffee seedlings, it is usually employed the binomial plastic bags x "ravine land". However, this practice increases transport costs, culture treatment of seedlings and also increases the possibility of dissemination of soil pathogens, mainly nematodes. In addition, it also causes environmental damages due to the great movement of soil. Every year, tens of millions of coffee seedlings are produced in Brazil, causing tens of thousands of cubic meters of soil to be moved.

The "ravine land" or subsoil corresponds to that of subsurface horizons, removed from the layer below the first 10.0 cm from the surface, which varies according to the soil type. To avoid the use of substrate contaminated with nematodes, soil should not be collected in areas in use or already used with coffee plantations, vegetable gardens and/or commercial nurseries of coffee plants and other species. The soil must be sieved to remove stones, clods, roots, etc.

The chemical and physical analysis of the soil should be performed to determine the need for its correction and fertilization of the seedlings, as well as the addition of organic material or sand for the texture adjustment. Clay soils with 60% or more clay require addition of coarse sand at the base of 10 to 20% by volume. Sandy soils with 15% clay or less require larger amounts of voluminous organic matter, 40% by volume (SANTINATO; SILVA, 2001).

The substrate for filling the bags can be prepared by following the composition for each cubic meter to be described:

• 700 to 800 L of "ravine land" or subsoil, sieved;
• 200 to 300 L of cattle manure or coffee straw, well seasoned;
• 5.0 kg of single superphosphate.

For the clonal seedlings production, the containers with the previously described substrate should be kept in rest for a period of not less than 30 days, before the cuttings planting, arranged in the permanent beds of the nurseries, receiving constant irrigation (Figure 31). Planting in freshly prepared substrate causes a significant decrease in the survival success index (SILVEIRA; FONSECA, 1995).

For the use of tubes, it is advisable to use substrates alternative to the traditional one, which uses "ravine land" as a base. Generally commercial substrates are used that are very efficient, but nevertheless, increase the cost of the seedlings production. In addition, variations between the several products available make it difficult to standardize culture practices.

For the use of these substrates, the use of controlled release fertilizers should be prioritized in order to favor the efficiency of the process (SERRANO; CATTANEO; FERREGUETTI, 2010).

Figure 31. Containers with substrate receiving irrigation before the cuttings planting.

When using alternative substrates for the seedlings production, special attention should be paid to their nutrition, since there is a need for frequent nutrient applications, mainly due to their leaching. Thus, the use of controlled release fertilizers of nutrients becomes one of the alternatives to increase the fertilization efficiency (SERRANO; CATTANEO; FERREGUETTI, 2010).

4.6 PLANTING OF SEEDS AND CUTTINGS IN THE NURSERY

4.6.1 Sowing for seedling production from seeds

For the production of coffee seedlings from seeds in order to avoid compromising the development of the root system, it is recommended that sowing be done directly in the containers. Two seeds are sown per bag, next to each other, directly in the containers, to a depth of 1.0 cm. Then, the seeds are covered with a thin layer of sand and the containers covered with burlap bags aiming to prevent irrigation water or rainfall from uncovering them, as well as conserve moisture and reduce the appearance of weeds (Figure 32).

Germination usually starts about 35 to 45 days after sowing. At that time, the cover applied directly on the beds should be removed. After the germination and the initial development of the new plants, the thinning is done, leaving only one of them in each container, the most vigorous and healthier. The thinned seedlings should not be harvested for replanting in another container.

4.6.2 Planting of cuttings for clonal seedlings production

The cuttings already prepared and ready for planting are, then, taken to the nursery and should be planted as soon as possible. They should be introduced into the substrate, previously prepared, up to the time of insertion of the leaves (Figure 33). In order to reduce the operations necessary for the replanting of lost cuttings, cuttings can be kept among the seedlings of the same clone in the spaces between the containers, in order to avoid returning to the clonal gardens for new collections of small amounts of cuttings.

Figure 32. Sowing, seeds and beds covering with the use of burlap sacks.

Figure 33. Height of cuttings insertion in the bags.

In favorable climatic conditions, "callus" appear between 30 and 40 days after the cuttings planting, and the first roots after 50 days. In the nursery, the seedlings remain for a period of about four to five months, depending on the time of year. In warmer periods, callus development and sprouting originated from the existing vegetative buds in leaf axils are usually faster, making it possible to produce seedlings in a total period of 120 to 130 days, including the period of at least 20 days for acclimatization (Figure 34).

4.7 CONDUCTION OF SEMINAL SEEDLINGS IN THE NURSERY

The seedlings monitoring should be done regarding the incidence of weeds, pests and diseases. The bags with the seedlings should always be kept free of weeds. The main pests are caterpillars, crickets and ants and the most common diseases are those that cause tipping, cercosporiosis and rust. The control of these pests and diseases is described in chapters 17 "Management of Conilon Coffee Pests" and 18 "Management of Conilon Coffee Diseases".

It is common, in nurseries, the death of seedlings caused by abiotic factors, that is, where there is no involvement of living organisms. It is important to make a correct diagnosis to avoid the use of inadequate measures, which often have no effect, as has been constantly verified.

Some general recommendations can help to reduce the emergence and spread of these diseases in nurseries: using resistant genetic material; fertilizing, with special care for nitrogen, especially in foliar applications; avoid excessive shading and over application of water; ensure good drainage of irrigation water; carry out, when necessary, spraying with specific pesticides in accordance with pests and diseases using always recommended and registered products for the crop.

Figure 34. Evolution of the root system and budding of conilon coffee clonal seedlings.

4.8 FERTILIZATION IN THE NURSERIES

Fertilization of seedlings should be carried out based on diurnal monitoring of the nursery and by supervision of nutritional status through foliar analysis. In average, approximately 15 to 20 g of urea or about 30 g of ammonium sulfate, diluted in 20 L of water, are applied every 30 to 40 days, totaling a maximum of four applications in the whole process of seedlings. In addition to nitrogen fertilization, micronutrients based products should also be applied every 40 days, at a dosage equivalent to one-third of the recommended amount for adult crops (BRAGANÇA; LANI; De MUNER, 2001).

After fertilization, the seedlings should be immediately submitted to irrigation with pure water, so that the fertilizers retained in the leaves are washed and do not promote their dehydration.

4.9 IRRIGATION

Seedlings nurseries irrigation relatively simpler than that of clonal nurseries, if care is taken to ensure that there is no shortage of water nor its excessive supply. The method used for the water supply can be even from manual watering with hoses or watering cans, with attention to the regular distribution.

Clonal seedlings should preferably be irrigated by the nebulisation microaspersion method (Figure 35). They shall be provided with timing devices to make the process automated, with intermittent irrigation. These devices activate the irrigation system at any given period of time or according to relative humidity in the environment. Timers can be purchased at specialized stores or built in the property with varying materials, depending on the grower's creativity.

In the clonal propagation, until the beginning of the emission of roots and buddings, it is important that the relative humidity of the nurseries interior is kept close to 100%, hence the need to maintain containers with water inside the humid chambers, according to the recommendation of Silveira and Fonseca (1995).

Figure 35. Irrigation of clonal seedlings nursery with water mist system.

4.10 ACCLIMATIZATION

The seedlings acclimatization is necessary so that they better support the stress conditions when they are definitively taken to the field. During the acclimatization process, the seedlings are removed from the nursery, where they were more protected, and then gradually exposed to the sun by gradually removing the cover and irrigated less frequently to better adapt to the field conditions. The seedlings acclimatization can be started from the third pair of leaves and at least 30 days before planting in the field.

In the acclimatization process, fairly rustic coverings can be used, such as those used in traditional nurseries, like palm leaves. The length of the referred process takes between 20 and 30 days, and may be longer in the case of conditions still unsuitable for planting.

When shade cover is used, acclimatization can be done by progressive exposure of the seedlings to the sun by gradually removing the nursery cover, avoiding the seedlings movement (Figure 36).

During acclimatization, it is recommended that fertilization be suspended or minimized to stimulate the root system growth, since after the definitive planting it will be more difficult to survive those seedlings that are more dependent on the availability of water and nutrients. The seedlings arrangement in the acclimatization beds should be made taking into account their size, that is, the most developed should be regrouped separately from the less developed so as not to slow down the growth of the latter (Figure 37).

Before the seedlings removal for definitive planting, the different batches must undergo an evaluation process in order to provide only the best quality seedlings to producers. The characteristics considered in this stage are: age, height, leaf color, symptoms of pest and disease incidence, amount and distribution of the root system, substrate consistency, among others (Figure 38).

Figure 36. Acclimatization process of clonal seedlings with gradual exposure to the sun.

Figure 37. Seedlings being regrouped during the acclimatization process, according to their size and vigor.

Figure 38. Seedling quality evaluation.

5 DISTRIBUTION OF CLONAL SEEDLINGS

At the time of the first clonal gardens development in 1993, the seedlings of the first clonal cultivars ('Emcapa 8111', 'Emcapa 8121', 'Emcapa 8131') were supplied to coffee growers for definitive planting, both separated and mixed, since all the clones of each cultivar had the same time of fruits maturation.

From the launching of the variety Emcapa 8141 - Robustão Capixaba, it was recommended that each clone be delivered separately by the need of planting in individual lines, because, although tolerant to drought, these clones did not present maturation at the same time. The technique of in-line planting allows the cultivation of all clones, regardless of the maturation season of each one, in the same area, since the harvest is done per line. The planting, following this technique, provides advantages such as increased productivity, improved product quality and ease in handling involving pruning and sprouting (FONSECA, et al., 2005; FERRÃO et al., 2012; FONSECA; FERRÃO, M.; FERRÃO, R., 2013).

In a similar way, it is recommended that the clones of the Vitória Incaper 8142 variety be planted in lines, since in spite of this variety gathers numerous characteristics of great interest, as in 'Robustão Capixaba', their clones present distinct fruit maturation time (FONSECA et al., 2005a, 2005b; FERRÃO et al., 2012). Therefore, it is recommended that each clone of the same variety be identified and delivered to nurseries in separate batches to enable planting in lines (Figure 39).

Figure 39. Seedlings of the clonal variety Vitória Incaper 8142 acclimated (A) and being prepared for distribution (B and C) for the clonal gardens development.

Even for the newly launched and recommended by Incaper for cultivation in the State of Espírito Santo cultivars, Diamante ES8112, 'ES8122' - Jequitibá and 'Centenária ES8132' (FERRÃO et al., 2015a, 2015b, 2015c), which have the their clones with the same season of fruit maturation, it is also recommended that their planting be carried out in individual lines, with the purpose of facilitating culture treatments and ensuring the presence of all, in the same proportions, in the crops to be developed.

All genetic material (cuttings or seeds) of coffee that will serve as means of propagation must be acquired from reputable institutions, registered by Mapa. These institutions must comply with IN 35, which establishes the norms for the production and marketing of coffee propagation material and its patterns, valid within the national territory in order to guarantee its identity and quality (BRASIL, 2012).

In order to provide interested parties with seedlings of their improved clonal cultivars for the implementation of new clonal gardens, Incaper maintains a program for the distribution of cuttings to registered nurseries, producers associations, cooperatives and city halls.

6 REGISTRATIONS IN THE MINISTRY OF AGRICULTURE AS A NURSERY

The registration of the producer in Mapa, as well as the registration of the nursery, must be done through the model forms, which refer respectively to the producer's registration, commitment term of the technical responsible for the nursery and application for the nursery registration.

For the seedlings production, the species and the variety to be multiplied must be registered in the Registro Nacional de Cultivares - RNC (National Register of Cultivars) of MAPA[1]. Information on the chemicals used to control pest and diseases in clonal gardens and nurseries should be obtained by the Sistema Integrado de Agrotóxico - SAI[2] (Integrated Agrochemical System).

The place for registrations in the State of Espírito Santo is the Delegacia Federal de Agricultura no Estado do Espírito Santo - DFA-ES[3] (Federal Office of Agriculture in the State of Espírito Santo).

7 FINAL CONSIDERATIONS

The use of improved materials due to the prevailing environmental conditions in the different conilon coffee growing regions and in the various production systems employed has been a preponderant factor for the significant advances recorded in the main Brazilian regions that cultivate the *Coffea canephora* species. These areas stand out for their different agronomic performance and for being considered as precursors in the use of other equally important technologies, although they depend on the genetic material to maximize the expression of their effects.

Cultivars of conilon coffee propagated by seeds have their multiplication carried out in a similar way to the arabica coffee, already well known to the Brazilian coffee growers, differing only with respect to the installation and conduction of the seed production fields, which must

[1]www.agricultura.gov.br
[2]www.anvisa.gov.br
[3]Av. Nossa Senhora dos Navegantes, Enseada do Suá, Vitória, ES
CEP: 29050-420 – (55) 27 3137 2743 – sffv-es@agricultura.gov.br

be in an isolated place.

The clonal cultivars, however, need to be propagated in an orderly way so that the clones that compose them are planted separately and in equal proportion following a series of important recommendations.

In general, the system of clonal gardens has been used in Brazil, in which matrices are cultivated for the purpose of supplying cuttings for the vegetative propagation of their respective clones. This system, started in the State of Espírito Santo, has been successfully adopted in the main Brazilian regions that use clonal cultivars, notably in Rondônia and Bahia.

Using traditional clonal gardens, it is necessary that, after obtaining, launching and recommending a new cultivar, the clones of each one of them be implanted and conducted for about two years so that they can generate the first cuttings for the seedlings production. For this reason, it is expected that the development of so-called super dense clonal gardens and their improvement, from now on, concretely provide the coffee growers with the possibility of seedling development of these new cultivars in a very short time, about seven months after implementation, reducing the time for the developed technology to be used more quickly.

In addition, other technologies related to the clonal seedlings production (length, thickness, position in the branches and shapes of the cuttings cut, hormones need, proportion of the leaves to be eliminated, among others) will add to the available technological set providing the possibility of greater competitiveness and sustainability to the activity.

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