

(RESEARCH ARTICLE)



Major weeds of Ecuador IV. Coffee plantations in Jipijapa

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Abstract

Coffee is a crop of economic importance in Ecuador, grown in area of 199 215 ha, 38,6% of it in Canton of Jipijapa, located in the south of the province of Manabí. Coffee here is grown by small farmers, who spend who spend little annually for the maintenance of plantations. One of the main constraints for getting optimal crop yields is the presence of weeds, which affect water stress during dry spells, and bring about deficient plant uptake of essential nutrients. Weeds are not usually properly controlled in all areas of this crop. Some farmers eliminate weeds twice or three times a year, others do that only once. The most common control method is hand hoeing, but some growers use foliar-applied herbicides, any of these practices are commonly carried out without knowledge of prevailing weed species. Suitable weed management strategy should include data about main weeds and their biology during dry and rainy seasons in Jipijapa. To this end, in 15 ha of coffee plantations during 2014 dry period and in another 15 ha during 2015 rainy one, weed cover and species present were visually evaluated using a scale 0-5, where 1- up to 5% weed cover and 4-more than 50%. These values were processed to determine Absolute and Relative Frequencies, average weed cover and finally Severity Infestation (SI). A total 39 weed species belonging to 19 families were found in both seasons, mostly broadleaves plants, while grasses were found in less shady spots of the plantations. The prevailing weed during rainy period appears to be *Senna occidentalis* followed by *Commelina erecta*, *Laportea aestuans*, *Alternanthera flavescens* and *Xanthosoma* spp., while during dry season, the fern *Pteridium aquilinum* was the leading species followed by perennials *Alternanthera flavescens* and the C4 grass *Megathyrsus maximus*. The species found only responded to the humidity conditions in each season and not to the effect of a certain control measure. Most of the evaluated plantations show poor crop management, scarce crop plant density, and even coffee planted in favor of the slope. Improved plantation management is the key measure to reduce the weed presence of weeds. In the rainy season, with more weed abundance, two early weeding operations, with an additional one later are advisable, while in the dry season, in the case of plantations with adequate shade, one weeding may satisfactorily reduce the weed presence. Perennial *Geophila macropoda*, found during rainy season, is a potential living cover in coffee plantations since it may help to reduce soil erosion and smothers weeds.

Keywords: Weeds; Coffee; Jipijapa; Ecuador

1. Introduction

Coffee is a crop of economic importance in Ecuador, which is grown in 199 215 ha, 68% of it corresponds to *Coffea arabica* species and 32% to *Coffea canephora* (6). The main coffee area in the country is Jipijapa, which has 38,6% of the total planted area. There high-quality Arabica coffee vars. Pacas, Caturra, Bourbon Rojo y Bourbon Amarillo are grown. For this reason, Jipijapa is called "La Sultana del Café" (*The Coffee Sultana*).

Jipijapa is located in the south of the Manabí province, on the coastal strip of Ecuador, at an altitude of 0 to 327 meters above sea level, with an average annual temperature of 21 °C and an annual rainfall of 1000 mm. In the coastal zone of

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Ecuador, there are two defined seasons: wet or winter, which begins in December and lasts until May, with more than 85% of annual rainfall, and the dry or summer season, which takes place between June and November.

In Jipijapa 66% of the farmers own small coffee areas, i.e. 1 to 10 ha; another small group (31%) has an average of 11-20 ha, and only small group of farmers cultivate more than 20 ha of the crop (7). This information asserts that expenses in the coffee farm are quite low. Less than 50% of coffee growers barely spend US\$ 160/ha annually, which is mainly intended for weed control and harvest, there is no other important cost in for crop management.

Therefore, weeds constitute one of the main concerns of farmers. However, it is known that some farmers carry out 2-3 manual weeding a year, others few combine this work with the use of foliar herbicide, but without taking into account the composition of the species present in the plantations.

Coffee is very slow growing perennial crop, with wide space between plants. Significant yield reductions may take place when weeds are not controlled timely and adequately (8, 10). Effects of weeds on coffee include water stress during dry spells, deficiencies of essential elements, reduction in yield and quality (3). In addition, some authors concluded in their studies in Brazil that adopted weed management in coffee plantations may have major effects on the soil environment, affecting physical, chemical and biological conditions (2). At the end, it may affect yield potential in coffee plantations.

Based on the importance of weed management in coffee, it is essential to know the main weed species, their frequency and abundance, as a way to plan appropriate management strategies and prevent losses from this biotic constraint. To this end, a study was conducted to determine frequency/abundance of weed species in Jipijapa coffee areas.

2. Material and methods

A weed survey was carried out in 15 plantations that amounted 30 ha, one part of the fields evaluated during wet or winter season and another in dry or summer time during the last four months of 2014 and the first five months of 2015. Chosen coffee plantations were those indicated by accompanying MAG technicians in conducted evaluations.

Evaluated fields were all on loamy or clay loam soils, planted with coffee (*Coffea arabica*) var. Sanchimor, except one field planted with var. Acawa. Most of the plantations have shade given by the presence of soursop, laurel, mango trees and banana, or the latter alone. Coffee planting distance was 2 m apart in rows with plants 1.25 m apart within the row. Fertilization is rarely practised, and weed management consists of 1 or 2 manual hand weeding during the year, or combined with one application of foliar herbicide, mainly paraquat (1,1'-dimethyl-4,4'-bipyridinium dichloride).

Using the score system (see below) reported previously (4), weed cover of present species was evaluated visually, going diagonally in each plantation whenever the slope of the height was not very steep. If it were the case, weed evaluation went around the plantation. Up to 6-8 sites of 1 m diameter were chosen for weed evaluation within each plantation. Scale-cover was as follows:

- 0 weeds
- 1-1-5%
- 6-25%
- 26-50%
- More than 50%.

Data processed to determine Absolute Frequency (FA), i.e. the number of times each species was found in each site, and Relative Frequency (F) in %, $F=FA/\text{no. sites in each field infested by a species} \times 100$.

Then with ΣI - Sum of the cover values and its average IM:

$$Im = \frac{\Sigma I}{N}$$

Where N is the number of fields infested by any species

Finally, Severity Infestation (SI) as:

$$SI = F \times IM$$

Obtained weed SI were grouped according to the seasons of the year (rainy and dry).

3. Results and discussion

Field evaluations resulted in a total 39 weed species belonging to 19 families during winter or rainy season. Grasses were found in less shady spots of the plantations.

3.1. Weeds found during winter season (rainy)

3.1.1. Pteridophytes

Dennstaedtiaceae: *Pteridium aquilinum* (L.) Kuhn

3.1.2. Monocots

Araceae: *Xanthosoma* spp.

Commelinaceae: *Commelina erecta* L.

Cyperaceae: *Cyperus difformis* L.

Poaceae: *Digitaria sanguinalis* (L.) Scop., *Echinochloa colona* (L.) Link, *Eleusine indica* (L.) Gaertn., *Leptochloa virgata* (L.) P. Beauv., *Panicum paniculatum* (L.) Kuntze, *Urochloa fasciculata* (Sw.) R. Webster

3.1.3. Dicots

Amaranthaceae: *Alternanthera flavescens* Kunth, *Gomphrena serrata* L.

Apocynaceae: *Prestonia mollis* Kunth

Asteraceae: *Ageratum conyzoides* L., *Bidens pilosa* L., *Cichorium intybus* L., *Millieria quinqueflora* L., *Sonchus oleraceus* L., *Vernonia cinerea* (L.) Less, *Xanthium strumarium* L.

Convolvulaceae: *Ipomoea hederacea* Jacq.

Euphorbiaceae: *Acalypha alopecuroides* Jacq., *Croton lobatus* L., *Euphorbia hirta* L., *Ricinus communis* L.

Fabaceae: *Alysicarpus vaginalis* (L.) DC., *Macroptilium lathyroides* (L.) Urb., *Senna occidentalis* (L.) Link, *Rhynchosia minima* (L.) DC

Lamiaceae: *Hyptis capitata* Jacq., *Ocimum basilicum* L.

Malvaceae: *Sida acuta* Burm.f.

Petiveriaceae: *Petiveria alliacea* L.

Rubiaceae: *Borreria laevis* (Lam.) Griseb., *Geophila macropoda* (Ruiz & Pav.) DC.

Solanaceae: *Acnistus arborescens* (L.) Schldt.

Talinaceae: *Talinum triangulare* (Jacq.) Willd.

Urticaceae: *Laportea aestuans* (L.) Chew

Verbenaceae: *Bouchea prismatica* (L.) Kuntze, *Priva lappulacea* (L.) Pers.

The number of weeds, 13 belonging to 8 families, in summer or dry period was much lower than in the rainy one. The only similarity found was the presence of grass weeds in less shady spots of the plantations.

3.2. Weeds found during summer or dry season

3.2.1. Pteridophytes

Dennstaedtiaceae: *Pteridium aquilinum* (L.) Kuhn

3.2.2. Monocots

Poaceae: *Cynodon dactylon* (L.) Pers., *Megathyrsus maximus* (Jacq.) B. K. Simon & S. W. L. Jacobs), *Panicum paniculatum* (L.) Kuntze, *Sporobolus indicus* (L.) R.Br.

3.2.3. Dicots

Amaranthaceae: *Amaranthus dubius* Mart. ex Thell.

Apiaceae: *Coriandrum sativum* L.

Asteraceae: *Bidens pilosa* L., *Emilia sonchifolia* (L.) DC.,

Convolvulaceae: *Ipomoea* spp.

Euphorbiaceae: *Euphorbia hirta* L., *Euphorbia hypericifolia* L.

Solanaceae: *Solanum nigrum* L.

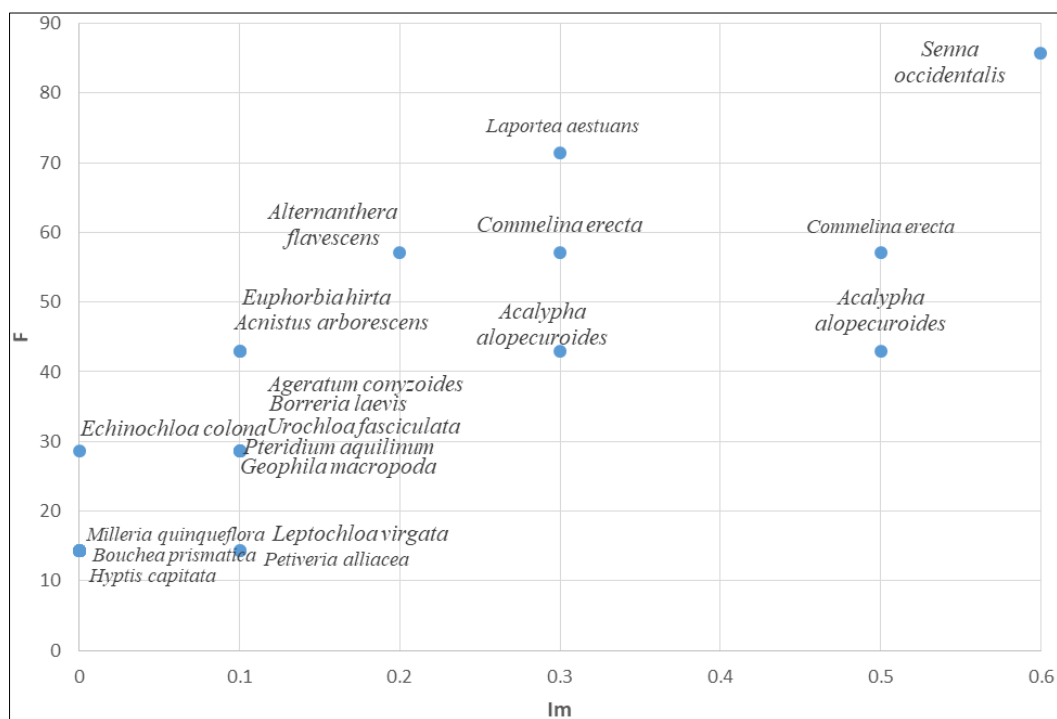


Figure 1 Major weeds during rainy period

The prevailing weed during rainy period appears to be *Senna occidentalis* followed by *Commelina erecta*, *Laportea aestuans*, *Alternanthera flavescens* and *Xanthosoma* spp (fig. 1). Some typical species frequent in coffee plantations in other countries were also found as *Euphorbia hirta* and *Petiveria alliacea*. Sixteen species showed extremely low SI, and for this reason, they are not shown in the graphs.

The abundance variation of *A. flavescens* in dry and rainy seasons is little. It likes to grow in undisturbed soil, reason why it is frequent in perennial plantations. Any weed control measure should be effective against this species in coffee of Jipijapa. *Xanthium strumarium*, called as “Hoja Ancha” (broad leaf) by farmers, is somewhat abundant in both seasons, but mainly in isolated spots inside plantations. Although perennial Rubiaceae *Geophila macropoda* was only found

during rainy season, it is a potential living cover in coffee plantations. This plant possesses fibrous roots and grows with slender creeping stems rooting at the nodes under plantain leaf shade. In Costa Rica cover of *G. macropoda* reduces erosion in all soil types in banana plantations and is useful for weed smothering; it may also reduce the reliance on chemical weed control (5).

During dry season, the fern *Pteridium aquilinum* was the leading species followed by perennials *Alternanthera flavescens* and the C₄ grass *Megathyrsus maximus* (formerly *Panicum maximum*) (fig. 2) called as Saboya in Ecuador, highly susceptible to lack of light and abundant in non-shady spots and where coffee plant density is irregular.

Apart from weed composition, it happens that manual weeding is usually conducted out of time, i.e. when undesirable plants have already done their damage by the uptake of nutrients and water. Most of plantations show poor crop management, scarce crop plant density, and even coffee planted in favor of the slope. All these conditions increase weed density. Tree shade helps to reduce weed growth, in addition the organic matter generated from fallen leaves and pruning forms natural mulch cover, which is effective in inhibiting weed growth (1).

Emphasis should focus on improvement of plantations as a primary measure to reduce the presence of weeds. In the rainy season, when there is usually more abundance of weeds, it seems advisable to carry out two early weeding operations, with an additional one later, while in the dry season, in the case of plantations with adequate shade, one weeding may satisfactorily reduce the weed presence. Good agronomic management with an optimal density of coffee plants is the key for feasible weed stand reduction.

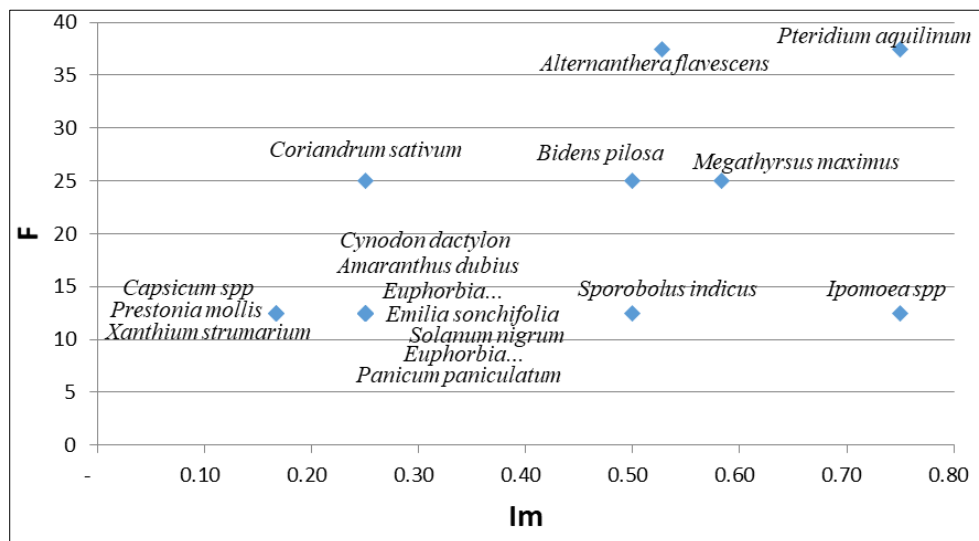


Figure 2 Major weeds during dry period

A suitable option for weed control is the use of cover crops. In West Ethiopia *Desmodium* sp. is recommended for the management of coffee wilt disease and for suppressing weeds (8). For the case of Jipijapa, *Geophila macropoda* although found only during rainy season, it is a potential living cover in coffee plantations, which may smother weeds as well as to prevent soil erosion. Other plant recommended in Costa Rica as cover in coffee plantation is *Tradescantia zebrina* (SCHNIZL.) D.R. HUNT (9), which should be tested and validated in Jipijapa as a previous step for its use.

Coffee plantations in Jipijapa are grown in a rugged relief, for this reason, the use of selective soil-acting herbicides is not advisable since these chemicals may leach and accumulate in lower areas of the field. Careful application of any foliar herbicide may replace hand weeding, but this should be done following label indications. If infestation is low, manual weeding is the best option.

4. Conclusion

The best and primary way to manage weeds in coffee plantations of Jipijapa is conducting an appropriate crop management, i.e., establishment of adequate crop density, trees for shade, and a potential living cover using a creeping plant able to prevent soil erosion and smother weeds. Additional hand weeding may be required according to the weed cover and the season of the year.

Compliance with ethical standards

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Disclosure of conflict of interest

The author has no pecuniary or other personal interest, direct or indirect, in any matter that raises or may raise a conflict with his duties as the leader of the project “Major weeds in the agriculture of Ecuador.” The present manuscript is of his exclusive authorship.

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