Agriculture, Ecosystems and Environment 269 (2019) 82–87

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Occurrence of potato taste defect in coffee and its relations with management practices in Rwanda

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ARTICLE INFO

Keywords:
Potato taste defect
Distribution
Antestiopsis thunbergii
Management practices

ABSTRACT

Coffee production is a critical export for Rwanda and a direct income source for many rural farmers. An undesirable raw potato-like smell found in parchment, green and roasted coffee beans and in brewed cups of coffee referred to as "potato taste defect" (PTD) affects coffee across the Africa Great Lakes Region. Two main insect pests of coffee, antestia bug (*Antestiopsis thunbergii*) and coffee berry borer (*Hypothenemus hampei*) occur in the same region and may be directly or indirectly responsible for the spread of PTD. The objectives of this study were to determine the distribution of PTD in Rwanda and to evaluate how crop management practices influence the occurrence of this defect in coffee. A stratified random sample of 338 coffee farms was selected and the density of antestia bug and damage to coffee berries attributed to antestia bug or coffee berry borer (CBB) were quantified. Management practices such as pruning, intercropping and insecticides application were recorded. A random sample of three kg of ripe cherries was collected from each farm, hand pulped, fermented for 24 h, washed, dried and tested. Processing did not include sorting by floatation or removal of insect - infested cherries. Potato taste defect was detected in about 5% of the samples. The PTD was distributed throughout the coffee producing regions of Rwanda with the highest incidence in the Central Plateau, Granitic Ridges and Eastern Plateau. Occurrence of PTD was significantly correlated with antestia bug density and damage but not to CBB infestation. Pruning significantly reduced the occurrence of PTD but intercropping did not affect the occurrence of this defect in coffee. This study suggests that PTD could be significantly reduced through proper control of antestia bug, but its elimination would also require understanding its mechanisms of infection.

1. Introduction

Coffee is a critical export commodity worldwide and is crucial to the economy of 70 countries in Africa, Asia and Latin America (Aerts et al., 2015). In Rwanda, coffee is the major foreign-exchange earner and significantly contributes to the country's total annual value of agricultural exports (Murekezi et al., 2014). Coffee is the main source of direct income for a considerable proportion of rural farmers and provides employment for thousands of workers in the coffee industry (Moss et al., 2017). Coffee from the Africa Great Lakes Region, including Rwanda, has been ranked among the best in the world (Gueule et al., 2015). However, the region is constrained by Potato Taste Defect (PTD) - an undesirable raw potato like-smell found in parchment, green and roasted coffee beans and in brewed cups of coffee. Potato taste defect diminishes the flavor experience and the perception of quality of finished coffee, reducing its value or causing it to be rejected by consumers.

Potato taste defect was first detected in the 1940s (Stolp, 1960) in the eastern part of the Democratic Republic of Congo, near the Rwandan border and therefore represents a threat to Rwanda. However, there is currently no information available on the occurrence and distribution of this defect in this country. Gueule et al. (2015) believe PTD is caused by a bacterium of the *Enterobacteriaceae* family that develops in coffee beans and produces Isopropyl–2–methoxyl–3–pyrazine (IPMP) and 2-isobutyl-3-methoxypyrazine (IBMP), the compounds that are responsible for the potato taste flavor. It has been proposed that this defect may be produced by the coffee plant as a stress response to feeding damage by antestia bug, *Antestiopsis thunbergii* (Hemiptera: Pentatomidae) (Jackels et al., 2014). Antestia bug is native to Africa but has spread to the coffee producing countries of Asia such as Pakistan,

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https://doi.org/10.1016/j.agee.2018.09.022
Received 2 April 2018; Received in revised form 13 September 2018; Accepted 17 September 2018
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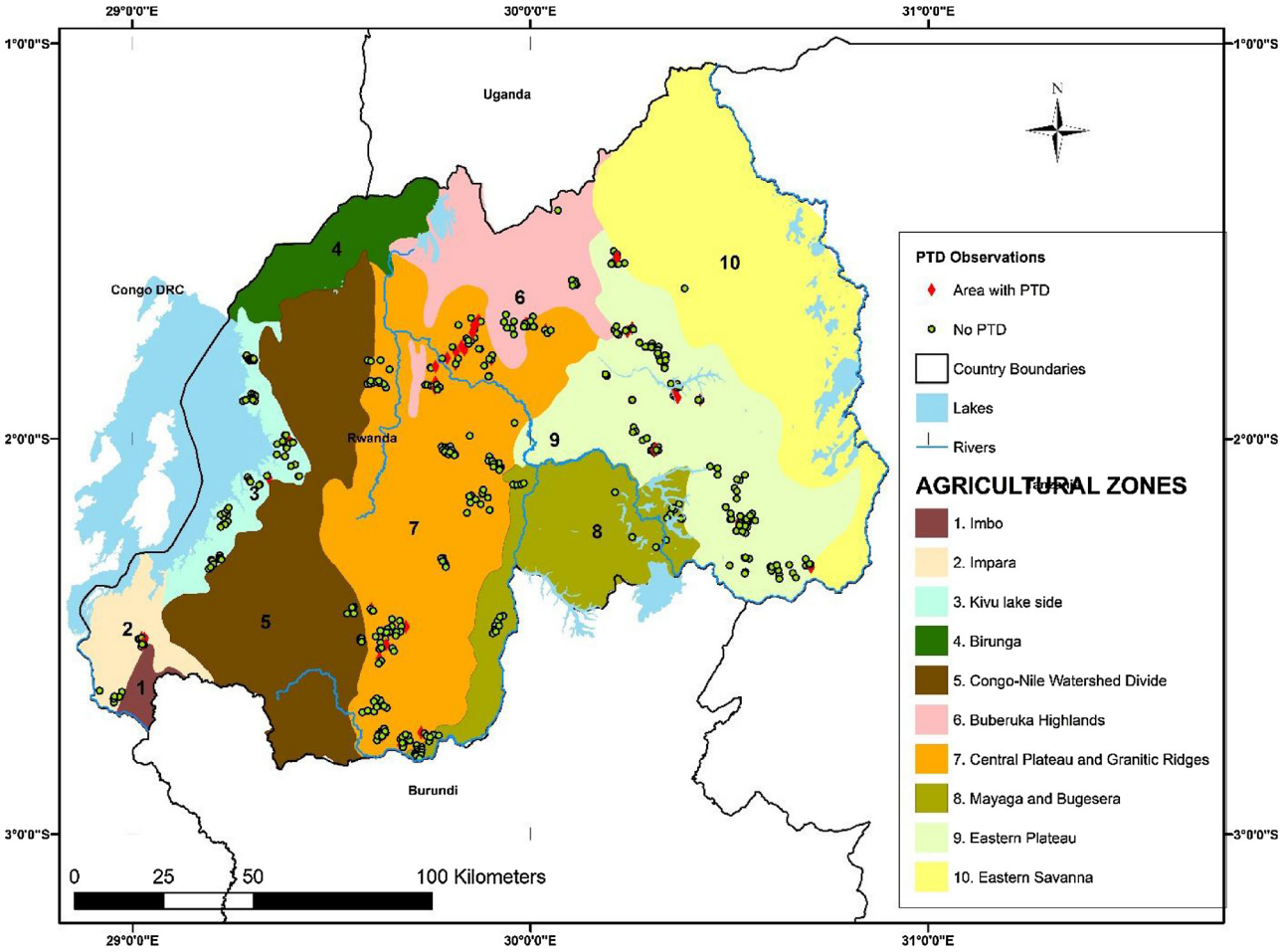

Fig. 1. Map showing areas sampled and the distribution of PTD in the coffee growing regions of Rwanda. The defect is distributed throughout the coffee growing regions of the country with the highest incidence in Central Plateau and Granitic Ridges (Zone 7) and Eastern Plateau (Zone 9).

India, Myanmar, Sri Lanka and Southern China (Rider et al., 2002). When antestia bug infests the coffee plantation during the onset of rains, it causes significant loss of flowers and severe infestations may prevent the tree from flowering (Waller et al., 2007). Antestia bug infestations are ubiquitous in coffee plantations but occur in patchy distributions possibly due to the insect's semio-chemical mediated reproductive behavior (Cilas et al., 1998). Greathead (1966) observed that antestia bug moves throughout coffee plantations to find more attractive trees for oviposition. Yield loss due to antestia bug has been estimated at up to 40% (Azrag et al., 2016). Although protection of coffee plantations against insect infestations decreases the occurrence of PTD in coffee (Bouyjou et al., 1999), the relationship between cherry damage by antestia bug and the occurrence of PTD in coffee is unknown.

Coffee berry borer (CBB), *Hypothenemus hampei* Ferrari (Coleoptera: Scolytidae) is another major coffee pest worldwide (Murphy and Moore, 1990; Damon, 2000). This pest, which is native to Africa, threatens coffee production in the Eastern African region (Jaramillo et al., 2011). According to Damon (2000), CBB affects mature and immature coffee berries, causes significant yield losses and diminishes the final quality of coffee. Though CBB does not affect stem, leaves or branches, it causes premature fall of coffee cherries, arrested berry development or decay (Damon, 2000). Coffee berry borer infests coffee trees, especially Arabica coffee at all altitudes in the major coffee growing areas but higher infestations generally occur at lower altitudes (Rojas et al., 1999). Feeding by CBB also creates holes into mature berries that serve as an entry point for secondary infections by bacteria and fungi, the pathogens responsible for wet rot of coffee berries (Damon, 2000). Although it is possible that the holes also serve as entry points for bacterium that causes PTD in coffee, the relationship between CBB damage and occurrence of PTD has not been investigated.

Pruning and insecticide application are important agricultural practices in coffee farming. Pruning shapes the tree canopy, facilitates field operations and satisfies the needs of crop productions and fruit quality. Pruning also opens up the coffee bushes and creates unfavorable conditions particularly for antestia bug while also improving insecticide penetration and efficacy (Bigirimana et al., 2012). Previous research has shown that monthly applications of insecticides against antestia bug combined with visual sorting of infested cherries and floating at the coffee washing station in Burundi, significantly reduce the percentage of PTD contaminated cups (Bouyjou et al., 1993). While pruning and insecticides sprays are known to reduce insect pest density and berry damage, their relationship to the occurrence of PTD in coffee is not well understood.

Intercropping in coffee plantations also can influence Antestia bug and CBB density and damage to coffee plants. For instance, growing coffee under shade of Agroforestry species such as *Leucaena leucocephala*, *Calliandra calothrusus* and *Albizzia sp*. increases Antestia bug severity and the amount of berry damage and losses in Cameroun (Mbondji, 1999). Similarly, intercropping coffee with food crops increases damage caused by antestia bug in Kenya (Mugo et al., 2013). However, presence of banana plants in coffee farms improves populations of *Corioxenos antestiae*, a natural parasitoid of Antestia bug which in turn reduces the bug population and its damage (Mbondji, 1999). Furthermore, coffee grown under shade of avocado (*Persea americana*) or grevillea (*Grevillea robusta*) reduces infestations of cherries by CBB

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