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Impact of Antestia bug (Antestiopsis sp.) on Coffee (Coffea arabica L.) Production and Quality

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Abstract
Coffee is the most important and valuable agricultural commodity in Ethiopia and also in the world by supporting the economic growth and providing job opportunity to millions of people. But, the yield and quality of coffee significantly reduced by biotic factors(diseases, insects, weeds etc.) and a biotic factors(temperature, drought, and rain pattern). This review paper aimed to assess the impact of antistia bug(*Antestiopsis spp*.) on coffee production and quality. Main topics included in this review were history and biology of antesia bug, damaging stages, specific plant parts affected by the pest (leaf, flower and flower bud, shoots and berry). Worldwide yield loss and specific yield loss both in Africa and Ethiopia were reviewed, and hence, the yield loss caused by the pest is 13% in the world and 96% in Africa respectively. The review also identified gaps and indicated future line of work.

1. Introduction

Coffee (*Coffea arabica* L.) is the most important and valuable agricultural commodity and beverage cultivated and marketed throughout the world and worth up to US $ 14 billion annually for producing country. More than 50 developing countries are earning 25 % of their foreign exchange from coffee, (Belay *et al*., 2016). In Ethiopia Coffee is the largest export crop and the backbone for the country's economy. Ethiopia is the largest producer of coffee in Africa and is the fifth largest coffee producer in the world next to Brazil, Vietnam, Colombia and Indonesia, contributing about 4.2 percent of total world coffee production (Abu and Teddy, 2010, cited by Belay *et al*.,2016). In Ethiopia, the average farmers marketed coffee is around 84% of their farm production. Totally, coffee contributed 70% to the total value of output sold. According to Gebreselassie (2008) report the 25% highly commercialized smallholders generated over 95% of their cash income from coffee sales, while the bottom 25% earned 63% of their cash income from selling food crops. Selassie and Bekele (2008) also indicates, 98% of the coffee, the latter being Ethiopia's leading export good. Private and state commercial farms produce just 6% of food crops and 2 percent of the coffee grown.

This high value crop constrained by many a biotic and biotic factors. The most common biotic factors are diseases caused by many etioletic agents, mainly the fungi and pests especially insect pests. The crop is prone to a number of diseases and insect pests that attack fruits, leaves, stems and roots and reduce the yield and marketability (Aebissa, 2012). Coffee insects are estimated to cause losses of about 13%, but in Africa the yield losses can be higher up to 96%. In different coffee plantations, there are four major economically important pests such as, white stem borer (*Anthores leuconatus)*, antestia bug (*Antestiopsis sp*.), coffee berry borer (CBB) *Hypothenemus hampei* and coffee leaf miner (CLM) *Leucoptera meyricki*. Other coffee pests have low economic damage (Aebissa, 2012; Nahayol and Bayisenge, 2012).

Insects are the major damaging pests of coffee and causes huge yield loss. Among those, *Antestiopsis* spp. (formerly in the genus *Antestia)* have been recognized as serious pests of *coffee Arabica* L . (Gearthead, 1971). The pentatomid bugs (*Antestia* spp.) now referred to the genus *Antestiopsis* (common name of antestia bug), are severe pests of coffee throughout Africa (Meulen and Schoeman, 1990). The antestia bug *Antestiopsis thunbergii* is a major coffee pest in East Africa. Nymphs and adults feed on all vegetative and fruiting parts of the coffee tree leading to yield reduction and poor quality of coffee beans, (Ahmed *et al*., 2016). The pest causes rotting of the endosperm, flower discoloration and flower drop off. It also attacks green berries and growing tips of coffee. As they feed, they inject saliva containing the spores of the fungus *Ashbya*. This fungus is thought to cause the taste defect, i.e. marked "potato" (very similar to a freshly cut raw potato) or "green, pea/peasy" taste defect (Mugo *et al.,* 2013). According to Mugo *et al*.(2013) report the density of Antestia bug ranged from 1-2 per tree considered as the economic threshold level that requires insecticide spraying so as to avoid economical crop loss (Coffee Research Foundation, 1989). A crop loss of 15-27% in total bean weight has been associated with infestation of 2-4 antestia bugs per tree feeding on shoots causes a marked reduction in growth, shortening of the internodes, and increased branching, producing a typical bunchy or matted growth (Meulen and Schoeman, 1990). In Ethiopia, among total of forty-seven insect pests of coffee were reported only two insect pests antestia bugs and coffee leaf minor are the major insect pests (Mendesil *et al*., 2008). According to the report, there are three(3) species of antestia bug, (*antestiopsis spp.)* in Ethiopia, namely *A. intricate* (Ghesquiere and Carayon), *A. facetoides* (Greated) and *A.orbitalis* Carayon. *A. intricate* is the most common bug found in all coffee growing areas except Hararghe, where only *A. facetoides* is found. Therefore, these review paper is aimed to undertake a

genuine review on impacts of antestia bug(*Antestiopsis* spp.) on coffee production and quality.

History and Biology of antestia bug

From the earliest days of coffee growing in East Africa, *antestiopsis spp*. have been reported as serious pests of *Coffea arabica* L . (Rubiaceae). Great bewilderment over the status and nomenclature of the forms found in East Africa arose as a result of using colour patterns only to attempt to distinguish species. But, it was recognized that *Antestiopsis orbitalis bechuana* (Kirkaldy) is the major species in eastern Kenya and Tanzania with *A. facetoides* Greathead in some areas at lower altitude, while *A. orbitalis ghesquierei* Carayon and *A. intricata* (Ghesquiere & Carayon) replace them in western Kenya and Tanzania and throughout Uganda (Gearthead, 1971). Different species of antestia bug were reported in Eastern Africa. According to Gearthead (1966) different species of antestia bugs are:

A. orbitalis orbitalis Westwood ; Cape Province.
A. orbitalis form faceta Germar ; Cape Province - Natal.
A. orbitalis forms ; Natal, Transvaal, Mozambique.
A. orbitalis bechuana Kirkaldy ; Rhodesia- E. Kenya.
A. orbitalis ghesquierei Carayon ; Katanga - Uganda, W. Kenya, and Ethiopia.
A. intricata Ghesq. & Cara. ; Ivory Coast - W. Kenya and Ethiopia.
A. facetoides Greathead ; Uluguru Mts - Mt. Kenya.
A. crypta Greathead ; Katanga.
A. falsa Schouteden; Transvaal and Tanzania.

It has striking patterns or markings in black, white or orange. The insect undertakes incomplete metamorphosis with life-chain of egg, nymph and adult. It undergoes four generations per year, but the number of adult is higher in summer with high mortality of nymphs. In contrary, the number of nymphs become increase with high mortality rate of adults in Winter. Both nymph and adult numbers began to rise from October (Meulen and Schoeman, 1990). Mendesil *et al*.(2008) also reported, average of 12 eggs were laid per female per day; on average, 324 eggs were laid per female. Oviposition of *A. intricata* started 12 days after female emergence. Peak oviposition rate was recorded at 25 days after adult female emergence. Egg to adult development period took a mean of 50.3±2 days. Total life cycle for female and male insects were on an average 237.3±7.8 and 185.5±10 days, respectively.

Damaging stages

As Kimani *et al*.(2002) stated the adults and nymphs are the damaging stages of antestia bug and they feed mostly on immature, green berries, from which they suck the sap, causing the fruits to shrink. Also Matsuura *et al.(*2014) reported adult and nymphs can feed on shoots and leaves of coffee plants but prefer to attack unripe coffee cherries. The attack of thus stages may not only causes physical damage to the coffee cherries but also facilitate fungal infection of the fruits, causing coffee bean rot and significant yield loss. Due to the damage caused by both nymphs and adults feed on the berries, can result the young berries to drop and the production of soft or rotten beans by the bigger berries (Aebissa, 2012). It also transmit a fungal disease, which infects developing beans and turns them into a white powdery mass. In Kenya, the disease is known as 'Posho (maize meal) bean'. After harvest, the insect may feed on the tips of coffee branches, stimulating development of shoots, which deplete the plant's resources but does not bear fruit. It may also attack flower buds, which turn black and fail to set fruit (Kimani *et al*., 2002; Matsuura *et al.,* 2014).

Target plant parts

Shoot and Leaf

Antestia bug can damage different parts of coffee plant causing great economic losses. Shoot or leaf is one of the target part. An adult and nymphal insects of antestia bug can feed on shoots and leaves of coffee plants but prefer to attack unripe coffee cherries (Matsuura *et al.*, 2014). According to Mugo *et al.(*2013) the insect suck young and mature leaves causing yellowing and heavy defoliation of coffee trees that affects the subsequent coffee production. Meulen and Schoeman (1990) also investigated *A . orbitalis* feeds on the shoots, flowers and on both the green and red berries with the result that the required food is available. The insect also feed on the tips of coffee branches, stimulating development of shoots, which deplete the plant's resources but, bear no fruit. It may also attack flower buds, which turn black and fail to set fruit (Kimani *et al.,* 2002). They also suck young and emerging seedlings of coffee plants causing malformation of branches, fan branching and feeding on spikes hence lowering yields and quality (Wangui, 2012).

Flowers and flower bud

Different authors indicated the devastating damages of antestia bug on coffee flowers and flower buds. According to Meulen and Schoeman (1990) report antestia bug can damage flowers causing the flower and flower buds to turn in to brown or black and finally drop off; the bud also fail to set flower. Feeding on shoots causes a marked reduction in growth, shortening of the internodes, and increased branching, producing a typical bunchy or matted growth. Wangui (2012) also suggested the antestia bug attacks on flowers buds, green berries, and growing tips of coffee. As they feed, they inject saliva containing the spores of the fungus. This fungus is thought to cause the taste defect, i.e. marked "potato" (very similar to a freshly cut raw potato) or "green, pea/peasy" taste defect. Antestia bugs, which are prevalent in increased temperature conditions cause flower buds to blacken. Blackening of flower buds, fall of immature berries, rotting of the beans with in the berry of conversion of the substance of the bean into a soft paste (Aebissa, 2012).

Berry damage

The adults and nymphs of antestia bug feed mostly on immature green berries, from which they suck the sap, causing the fruits to shrink. The attacks may not only causes physically damage of the coffee cherries but also, facilitate fungal infection and transmission from diseased plant to health plant thereby causing coffee bean rot and significant yield loss. In Kenya, the disease is known as 'Posho (maize meal) bean (Meulen and Schoeman; 1990; Kimani *et al.*, 2002). *A . orbitalis* feeds on green and red berries as well as shoots and flowers with the result that food is available throughout the year (Meulen and Schoeman, 1990). It suck berries and young plants causing malformation of branches, fan branching and feeding on spikes hence lowering yields and quality. No one knows it has attacked until the pulping process exposes darkly stained zebra-striped parchment coatings, and beans within are shriveled and black, decayed with the fungus which often accompanies it (Kirkpatrick, 2003 cited by Wangui, 2012). Suggestions from different authors indicates that, the bugs pierce the fruits, entering with their beaks into the endosperms of the seeds, and inject spore material into the coffee beans. The result of this feeding are the following types of damage: fall of immature berries and rotting of the beans with in the berry of conversion of the substance of the bean into a soft paste (Aebissa, 2012. It is a major coffee pest in East Africa with major damaging agents of nymphs and adults feed on all vegetative and fruiting parts of the coffee tree leading to yield reduction and poor quality of coffee beans (Ahmed *et al.,* 2016).

Over all yield loss

Feeding on different parts of coffee plant, antestia bug causes huge yield and quality loss. The main damage caused by the pest mainly *A. orbitalis* to coffee is the transfer of the fungus *Nematospora* sp., which causes rotting of the endosperm. After the flower bud is sucked by the insect, it becomes brown or black casing the flowers failed to set. Feeding on shoots causes a marked reduction in growth, shortening of the internodes, and stunted growth. The pest mainly *A. orbitalis* also suck immature berry and causes the berry drop off. In a such way, the yield loss in the world estimated to about 13%, but in Africa the losses can be higher up to 96% (Meulen and Schoeman, 1990; Waterhouse and Norris, 1989 cited by Nahayo1 and Bayisenge, 2012).

The major coffee insect pests varied in their severity on coffee as a result of shade. According to Kimani *et al.* (2002) report in some insect pests, shade depressed their severity while others were positively favored .Coffee under the shade had significantly higher infestation by the *antestiopsis spp.* than non- shaded coffee over the three experimental seasons. They infest on coffee beans can lead to low coffee quality. A crop loss of 15-27% in total bean weight has been associated with infestation of 2-4 antestia bugs per tree. Abedeta *et al*.(2011) also determined that, *antistia spp.* are the most frequently observed insect and prevalent at endosperm enlargement stage. The percentage of incidences ranged between 0.65% at Yayu to 11.62% at Berhane-Kontir FCPs.

In Kenya, the disease known as 'Posho (maize meal) bean's which is caused and transmitted by the bug is the most damaging and causes huge yield loss. The diseases infects developing beans and turns them into a white powdery mass. After harvest, this bug may feed on the tips of coffee branches, stimulating development of shoots, which deplete the plant's resources but bear no fruit. It may also attack flower buds, which turn black and fail to set fruit (Kimani *et al.* 2002; Nahayo1 and Bayisenge, 2012).

When the antestia bug infestations are high, the growing points are also damaged, resulting into dense matted growth; such coffee trees results low yields with poor quality beans. Infested berries develop dark brown patches. They also sometimes attack foliage and pierce the fruits, entering with their beaks into the endosperms of the seeds, and inject spore material into the coffee beans. The result of this feeding are blackening of flower buds, fall of immature berries, rotting of the beans with in the berry of conversion of the substance of the bean into a soft paste; on the drying tables the parchment shows longitudinal brown streaks ("Zebra-beans") and multiple branching internodes(Aebissa,2012).

Conclusion

Coffee (*Coffea arabica* L.) is the most important and valuable agricultural commodity and beverage cultivated and marketed throughout the world. Millions of peoples directly or indirectly depends on cultivation and marketing of coffee. In Ethiopia majority of its hard currency depends on coffee exporting and majority of the people improve their livelihood via enhancing their income from coffee selling.

Coffee production and quality can be constrained by abiotic and biotic factors. But, the most limiting factor is biotic factors such as, diseases, insects, weed, nematodes and vertebrates. Coffee insect pests are the most important yield and quality limiting factor which can reduce 13.5% of world's coffee production. In Africa these figure increased in to 96% yield loss. The pentatomid bugs (*Antestia spp*.) now referred to the genus *Antestiopsis* and common name antestia bug, are severe pests of coffee throughout Africa especially in East Africa. The insect is localized around East Africa coffee producing countries such as Uganda, Kenya, Ethiopia and Ruanda. The infestation is high around sub-tropics and tropics where temperature is high enough for reproduction for the pest.

The pest can damage leaf, flower, flower bud, immature and mature berry and shoot tip. The most devastating damage caused by the pest is its transmission of fungal disease. While sucking the berries, they vomit the sticky substance with fungal spore causes fungal disease called *Nematospora spp.* or " Posho". Suddenly, the disease can disseminate to health berry and flowers. The final result of sucked berry is "zebra" appearance which typically reduce coffee quality. Immature sucked berry become drop-off causing huge yield loss.

Future prospects

In Ethiopia, more detail information on amount of yield loss and quality reduction caused by the pest is crucial and needs further study in order to give attention and control the pest.

Abedeta *et al*.(2011) reported antestia bug population can increase with increasing of shade level, where as other authors declares shade is the most important tool for disease and insect pest management including antestia bug; because, in shade area the population of natural enemy can increase with reduction in pest infestation. These information are contradict with each other and needs further study.

Detail survey on distribution, infestation and critical season at which the severity is high should have to be undertaken.

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