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Review [Revisión]

AN OVERVIEW ON SOME BIOTIC AND ABIOTIC FACTORS AFFECTING THE POPULATION DYNAMICS OF LEUCAENA PSYLLID, *Heteropsylla Cubana* Crawford (HOMOPTERA: PSYLLIDAE): CONTRIBUTORY FACTORS FOR PEST MANAGEMENT

[PANORAMA GENERAL SOBRE LOS FACTORES BIÓTICOS Y ABIÓTICOS QUE AFECTAN LA DINÁMICA DE LA POBLACIÓN DEL PSÍLIDO *Heteropsylla cubana* Crawford (HOMOPTERA: PSYLLIDAE) EN LEUCAENA: FACTORES QUE CONTRIBUYEN EN EL MANEJO DE PLAGAS]

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SUMMARY

The present review was written with the objectives of providing basic information for pest control about leucaena psyllid, *Heteropsylla cuban*a Crawford (Homoptera: Psyllidae) the most destructive insect pest of *Leucaena* sp. In the regard of pest control, the review focus on discussing the findings of the existing researches about the factors affecting the distribution and seasonal fluctuations of *H. cubana* in the world. These factors are biotic such: biological control agents, and abiotic such: climatic factors, leaves chemical composition and genetic control which significantly affect pest population. A basic understanding of the relationship of these factors with psyllid population is important in developing an integrated control strategy for psyllid in leucaena and determining the potential pest control needs under the given biotic and abiotic factors trend. Besides, develop some concepts of pest control which effect directly and indirectly on the survival and population dynamics of *H. cubana* around the world.

Keywords: Biological control; chemical composition; climatic factors; population fluctuation.

RESUMEN

La presente revisión fue escrita con el objetivo de proporcionar información básica para el control del psílido *Heteropsylla cubana* Crawford (Homoptera: Psyllidae). Una de las plagas más destructivas de Leucaena sp. La revisión se centra en la discusión de los resultados de investigaciones existentes sobre los factores que afectan la distribución y las fluctuaciones estacionales de *H. cubana* en el mundo. Estos factores son, tanto bióticos, tales como: agentes de control biológico y abióticos como: factores climáticos, composición química de las hojas y el control genético el cual puede afectar significativamente la población de plagas. Un conocimiento básico de la relación de estos factores con la población del psílido es importante para el desarrollo de una estrategia de control integrado del psílido en leucaena y determinar el potencial necesario para el control de plagas considerando los factores bióticos y abióticos. Además, el desarrollo de algunos conceptos de control de plagas que afectan directa e indirectamente en la dinámica de supervivencia y de población de H. *cubana* en todo el mundo.

Palabras clave: Control biológico; composición química; factores climáticos; fluctuación poblacional.

INTRODUCTION

Leucaena leucocephala (Lam.) de wit the fast growing tree has been known as a miracle leguminous tree for its long life, wood fuel source, shade crop for coffee and cacao. In the regard of animal production, leucaena is the important fodder crops around the world for its highly nutritional value compared to alfalfa (Shelton and Brewbaker, 1994; Tim, 2009).

In the past, the successful spread of the common leucaena in the tropical world may have been due to its vacancy of main diseases and pests behind, but recently leucaena psyllid, *H. cubana*: is a small yellow-green insect about 1-2 mm long and aphid-like sometimes called jumping plant lice adapted to feed on young growing shoots of Leucaena. The psyllid limits the continued use and expansion of leucaena trees. Moreover, it achieved international notoriety in the early 1980s when outbreaks and devastating defoliation of leucaena plantings were first detected in Florida and Hawaii with an extremely rapid rate of spread. Therefore, it was reported as a serious pest almost exclusively on *L. leucocephala* for the ability of completing its life cycle only on plants related to genus *Leucaena* and a few to a lesser extent on closely related mimosoid leguminous trees in different countries such as Florida and Hawaii (USA), Mexico, and Central America (Bray 1994). From there it spread rapidly and it is reasonable to assume that, sooner or later, all areas where leucaena is grown will be affected (Bray, 1994; Geiger *et al.*, 1995; Olckers, 2011).

Accordingly, results of pest control studies indicated that the variation in the extremely rapid or slow rate of psyllid population spread from area to another, is depending on a complex set of interactions between leucaena growth, climatic factors (particularly moisture), psyllid mortality factors, and other influence factors are largely responsible for its dispersal, together with movement by aircraft and other man-made transportation (Bray, 1994; Morris, 2000).

Therefore, many of psyllid's control programs concentrated on the contribution of factors affect the population of psyllid as a trend for pest control such as: predators, parasitoids, and entomopathogens; biology and behavior studies of psyllid; and producing new resistant accessions of leucaena (Geiger and Andrew, 2000; Singh, 2004; Finlay-Doney and Walter, 2005; McAuliffe, 2008; Lawrie, 2010; Shivankar, *et al.*, 2010).

This discussion of the existing researches to clarify the optimal use of the biotic and abiotic factors in controlling the population of leucaena psyllid. Besides, the explications of these effective factors, instead of using chemical control which can't be used with such animal fodder crop.

DISTRIBUTION OF LEUCAENA PSYLLID

In recent history, psyllid is a typical example of the risk of pest outbreaks in *L. leucocephala* plantations across the tropics and widely distributed by (Nair, 2007), known from its native habitat in Latin America, Florida in late 1983, Hawaii in April 1984, the Philippines and Taiwan, In 1986 it was noticed in Indonesia, Malaysia, Thailand, southern Myanmar, southern China and neighboring countries. Thus in less than 10 years, and subsequently this pest has spread from its native range in tropical America, across the Pacific to Asia and Africa – an unusual spread for an insect. In 1987 it appeared in the Andaman Islands in India and in Sri Lanka, and the next year in southern peninsular India. The westward movement continued, and in 1992 infestations were noticed in the African continent, in Tanzania, Kenya, Uganda, and Burundi and by 1994 in Sudan and Zambia (Geiger *et al*., 1995; Ogol and Spence, 1997).

POPULATION DYNAMICS OF LEUCAENA PSYLLID

Psyllid populations are normally fluctuating quite widely over time. Different levels of pest abundance occurring in different parts in the same tree, according to the differences in the growth stages of *Leucaena* sp. Apparently, leucaena trees are vulnerable to high infestation of psyllids in the stage of producing new shoots and leaves because the young shoots of both native and giant varieties have been infested by high numbers of psyllid proportions in outbreaks (Fig. 1), with monthly mean numbers ranged from 0 to 44 nymphs and from 0 to 12.5 adults per shoot. Meanwhile, the ratios of nymphs per adult ranged from 3 to 13.4 and the population of psyllid has been found around the year (San Valentin, 1988), in India, the new shoots has been usually observed by heavy infestations; up to 3000 nymphs and adults per 15 cm of terminal shoot (Nair, 2007), and in Northern Thailand, the psyllid populations were highly boomed in juvenile leaves of leucaena, and then crashed when vegetative growth outpaced by Geiger and Andrew (2000).

BIOTIC FACTORS AND THE POPULATION DYNAMICS OF PSYLLID

Fecundity and other characteristics effecting on psyllids life cycle and its population dynamics

The population rates in all organisms are varies according to the interplay between ovipositing rates;

total number of eggs, adult's size, and periods of life cycle. These factors have been reviewed by Hodkinson (1974). The life cycle of *H. cubana* varies from location to another, with average (10 - 20 days) from egg to adult with several overlapping generations per year, and in tropical regions a population doubling time of 2.52 days to facilitate the massive population increase (Napompeth, 1994; Geiger *et al*., 1995; Olckers, 2011). In agreement with the observation that body size declined steeply during the population crash at the beginning of hot weather (NBCRC 1996; Napompeth 1998; Villacarlos *et al*., 1989). In Northern Thailand, there are a significant relationship between psyllid fecundity and various measures, such as the size of adult body and number of eggs laid over a 96-h period by Geiger and Andrew (2000). Average fecundity (eggs per day ± SD) was 51.0 ± 18.0 (n = 14) for non-desiccated females, with a maximum of 154. The regression during 96-h of total fecundity and measures of body size x (body length × head width^2) for 37 adult psyllid in laboratory studies was $y = 516.5x - 150.1$, $r^2 = 0.5042$, $P < 0.001$, $n = 37$, SE(y) = 102.9. The population dynamics of psyllid fall down under high temperatures, because it reduces both of body size (hence fecundity), and egg size by Geiger and Andrew (2000), and the total numbers of laid eggs on leucaena are the indicator of its upcoming arrival rates by Finlay-Doney and Walter (2005).

Biological control

Biological control agents such as predators, parasitoids, and entomopathogens are automatically regulating the population of any insect pests, and its absence cause severe damage to host plants especially for exotic pests in a new environment. The damage could be continuing until the populations of natural enemies build up. Exactly, that's what happened with psyllid at the time of its first spread, the psyllid caused severe and extensive damage to leucaena in Asia and Africa and in its native Central America, at a time when leucaena has been widely promoting in agroforestry (Rao *et al.,* 2000). Then, successive control by natural enemies (Bray, 1994; Shivankar *et al.,* 2010).

Predators and parasitoids

At any environmental system there are some natural enemies feeding on one or more stages in the life cycle of its pest. In this regard, there are considerable literatures on *H. cubana*'s natural enemies in native and exotic locations. Biological control efforts against psyllid were succeeded by using specific natural enemies such as the predators, *Curinus coeruleus* Mulsant and *Olla v-nigrum* Mulsant (Coleoptera: Coccinellidae), and the parasitoids, *Psyllaephagus yaseeni* Noyes (Hymenoptera: Encyrtidae) and *Tamarixia leucaenae* Boucek (Hymenoptera: Eupelmidae) by Shivankar *et al.* (2010). In contrast, some little countries rejected biological control due to its highly cost, and infective results on controlling psyllid populations (Shelton *et al*., 1998; Geiger and Andrew, 2000).

Figure. 1. Presents the infestation of high population numbers of Leucaena psyllids, *Heteropsylla cubana* Crawford infesting the new shoots of *Leucaena leucocephala* (Lam.) De Wit.

Successful trials of biological control agents. The larvae and adults of the common Ladybirds (Coleoptera: Coccenillidae) are good in this respect of psyllid control and greatly contributed in reducing psyllid populations in many localities (Funasaki, 1989). The predator, *C. coeruleus* is a handsome ladybird beetle about 4 mm long originally from Mexico. It is recognized by its iridescent blue-black color and orangish ̋Cheeks̏ by Geiger *et al.* (1995). A significant efficiency in using *C. Coeruleus* was identified in Hawaii and many several countries as Southeast Asia in attacking psyllid larvae (Bray, 1994). In its native range it was found preying on psyllids, although *C. Coeruleus* was originally imported from Mexico to Hawaii in 1922 to control another pest, the coconut mealybug, *Nipacoccus nipae* Maskell (Homoptera: Pseudococcidae). But, it controlled another pest, leucaena psyllid and due to its entrance to a new environment it was rare and hardly found until the arrival of leucaena psyllid. Then, *C. Coeruleus*, has become the most abundant species of Coccinellidae in Hawaii and important predator for leucaena psyllid (Napompeth, 1994). Likewise, in Cuba a successful predatism model of *C. Coeruleus* had been done by Valenciaga *et al.* (1999) for controlling psyllid population with significant results presenting those Coccinellidae predators and other natural enemies are capable to keep the psyllid populations below the economic injury level (E.I.L.) in different agro ecosystems. In India, *C. coeruleus* was imported from Thailand to study the biological suppression of psyllids by Singh (2004), after well establishing of the predator in the fields, and about four months after release 20-30 adults per tree, the grubs consumed 10.630 eggs and 3.500 nymphs during their lifetime. The predator population starts building up in May and reached its peak in December to February, and the psyllid population declined from November and remained so up to March. Also, it has spread on its own to an area of more than 20 sq km in Bangalore and in about two years, after release, the population of psyllid was drastically reduced and the predator firmly established in the released sites. The reduction of pest population occurred on 20 marked trees per ha., after releasing 20 adults of predator per tree twice during July and October or about 1,000 to 5,000 beetles per hectare of leucaena trees, and weekly observation of *C. coeruleus* its superiority at released sites by Singh (2004).

The parasitoid, *Psyllaephagus* wasp which attacks psyllid with more specification to the genus *Heteropsylla*, but it hasn’t released widely (Bray, 1994). Furthermore; the predator Ashy Gray Lady, *O. v-nigrum* was introduced from Mexico into Hawaii in 1908 for the controlling scale insects (Geiger *et al*., 1995). The *O. v-nigrum* population was sparse, then significantly increased at the arrival of leucaena psyllid and actively attacked psyllids, but it wasn’t abundant such the other Coccinellidae predator, *C. coeruleus*. The indigenous natural enemies *C. coeruleus* and *O. v-nigrum* suppressed psyllid populations during the early years of its presence in Hawaii, although they considered general pest feeders (Napompeth, 1994).

Furthermore, the parasitoid, *P. yaseeni*, was reared in Thailand at laboratories for the future field release of leucaena psyllid mummies. It has firmly established and widespread in all areas with significant results during the season of psyllid’s peak from October to March, and the parasite densities were much higher than psyllid (Winotai, 1989; Napompeth, 1994).

Both of *C. coeruleus, P. yaseeni*, in Thailand, covered most of adjoin countries to Thailand that never introduced these biological control agents for the highly abilities of fast spread. Therefore, it can be concluded that *C. coeruleus* and *P. yaseeni* could widespread throughout continental southeastern Asia throughout the introduction (Napompeth, 1994).

The biological control was accepted to control psyllid in different countries for a number of reasons. Historically, most pests in order Homoptera easly can be defeated by biological control (Greathead, 1989; Waage, 1989). Benefits ⁄ cost ratios for biological control programs are high, rating from 1.5:1-150:1 (Norgaad, 1988; Tisdell, 1990). In case of its success, it could be a permanent control having the most ecologically sound option with an equal benefits at all economic starts.

Non successful trials of biological control agents. Biological control was rejected in little countries such as Vietnam for its highly cost in obtaining the specific natural enemies, and the efforts for moving these agents from country to country, in spite of identifying about 30 species of natural enemies including three species of spiders, and six species of fungi (Shelton *et al*., 1998). Although, *C. coeruleus* had a partial success in Indonesia (Mangoendihardjo and Wagiman, 1989; Wagiman *et al.*, 1989), but it was failed to be established in many seasonal-dry areas (Funasaki *et al*., 1989; Oka, 1989; Wagiman *et al*., 1989).

The Coccinellid predator, *Olla v-nigrum* has also been introduced widely but it appears ineffective to control psyllid (Chazeau *et al*., 1992). Also, the parasitoid *P. yaseeni* never succeeded in regulating psyllid population, because the high numbers of psyllid were fluctuated normally when *P. yaseeni* are existence and there was no evidence of its ability to control psyllid populations by Geiger and Andrew (2000).

In conclusion, the exploration of the psyllid's native area for further predators and parasites should continue. It is not an easy task, and any new organism will need to be carefully tested before release (Bray, 1994).

Entomopathogens agents in controlling psyllid

Fungi, as entomopathogen scored high percent of reduction (82%), in Taiwan, among the populations of psyllid during heavily infested leucaena plantation by using the fungicide *Beauveria bassiana* (Liu *et al*., 1990). Another, epizootics of fungi *Entomophthora* sp., *Entomophaga* sp., and *Fusarium* sp. were observed in Northern Thailand causing significant reductions in psyllid populations (91% mortality), during two weeks in the period of maximum rainfall precipitation by Geiger and Andrew (2000).

ABIOTIC FACTORS AND THE POPULATION DYNAMICS OF PSYLLID

Climatic factors and the activity of psyllid

There were a number of attempts to assess the effects of environmental factors on population dynamics of psyllid (McAuliffe, 2008). The psyllid pressure In a humid-tropical site (1800 mm annual rainfall) in Indonesia, was negatively correlated with rainfall, and positively correlated with solar radiation and wind velocity ($r^2_=$ 0.51, 0.52 and 0.68, respectively) by Mangoendihardjo *et al*. (1990). The same result was emphasized in Australia, Queensland, when psyllid populations reduced during the periods of intense rain (McAuliffe, 2008).

In wet seasons, rainfall deterred the populations whereas strong winds during the dry season helped in disseminate and increase the numbers of psyllid (Mangoendihardjo *et al*., 1990), because it was noticed in Kenya that the physical effects of rain washing the mature and immature stages of psyllids. Therefore, lowered psyllid damage occurred during wet seasons by Wandera and Njarui (1998). In the sub-humid, seasonally dry tropics of Thailand, psyllid peak numbers occurred at the end of the dry season and the beginning of the wet season (Napompeth, 1989). In cooler climates, psyllid numbers were high throughout the year at Southeast Queensland and upland regions in Hawaii (Austin *et al*., 1996, Castillo *et al*., 1997).

In the drier sub-humid environments of Central Queensland (650 mm annual rainfall), psyllids aren't seen during dry or windy weather, but populations build up quickly during rainy periods with high relative humidity. A 3-years evaluation of a large collection of *Lecaena* accessions at Los Banos, Philippines (humid tropical site with 2100 mm annual rainfall) and at Brisbane, Australia (sub-tropical with summer dominant rainfall of 1500 mm annually) provided some insights into the effects of climatic parameters on psyllid damage. Psyllid pressure was assessed by psyllid damage to susceptible *Leucaena* accessions. Plant responses to climatic changes may also affect the severity of psyllid damage, thereby confounding studies based solely on psyllid damage. However, psyllid damage scores (Wheeler, 1988) are highly correlated with psyllid populations and the minimum scores only occurred in the absence of psyllids by Bray and Woodroffe (1988).

At subtropical Brisbane, psyllid pressure was high throughout summer, autumn and winter but was consistently low during the spring, a season associated with low rainfall and relative humidity, cool nights and warm days. At this site, significant positive correlations were obtained between psyllid damage and mean minimum temperature ($r^2_=$ 0.30), mean maximum temperature ($r^2_=$ 0. 17) and mean daily temperature ($r^2_=$ 0.22), indicating that psyllids may be favored warm temperatures. The study also showed that there was little or no psyllid damage when mean minimum temperatures were less than 10 °C. These findings confirmed those of (Austin *et al*., 1996) in Florida where low mean daily temperatures below 12 °C were associated with low psyllid populations. At tropical Los Banos, a negative significant relationships was obtained between psyllid damage and mean daily maximum temperature ($r^2_=$0.62), mean daily radiation ($r^2_=$0.46) and mean daily temperature ($r^2_=$0.42). The results showed that psyllid damage was low at maximum temperatures above 33°C and confirmed the findings of (Patil *et al*., 1992) who identified an upper developmental temperature range for psyllids of 30-35 °C under laboratory conditions. However, relative humidity had no discernible effect on mortality (Baker *et al*., 1993), none psyllid matured in 2 replicates when mean temperatures inside the field cages were 29.5 and 29.1 ºC and maximum temperatures over 36 ºC. A regression of development rates on mean temperatures yields a lower temperature threshold of 9.68 ºC. Furthermore, psyllid populations at valley sites fell dramatically at the onset of the hot season, when mortality and desiccation of adult psyllids were widespread.

In tropical countries such as Mexico, Thailand, Papua New Guinea and northern Australia, the psyllid is most active during the cooler months (Napompeth, 1994; Geiger *et al*., 1995; Geiger and Gutierrez, 2000). The insect also has a distinct upper thermal limit and numbers often decline substantially during warmer periods (Napompeth, 1994).

Generally, psyllid population is affected by temperature, moisture, humidity and exposure to wind

(Geiger and Andrew, 2000; McAuliffe, 2008) and the ups and downs of the psyllid populations are related to an optimum cooler temperature range and the availability of tender shoots in Hawaii. Also, psyllid damage is a result of interaction between several different climatic factors (Napompeth, 1994). But in fact, there was a little agreement between different studies in the effective climatic factor among weather factors on the dynamics of psyllid during correlation studies between climatic factors and psyllid pressure (Mullen and Shelton, 1998). Furthermore, the cool or dry seasons aren't the reason behind the highly psyllid damage, as a result of the observations of two experimental years in Kenya that the high level of psyllid pressure occurred due to the decline in natural eneimes numbers or the site climatic factors (Wandera and Njarui, 1998).

Chemical compositions of leaves and shoots

The effects of mimosine, tannins, phenols, and fibers as chemical compositions on animal food production were taken in consideration by researchers, especially mimosine and tannins (Wheeler *et al*., 1995) because, it was noticed in Australia that *Leucaena* was free from insect pests infestation in the past due to the insecticidal properties of the mimosine content in the growing young leaves. The mimosine content varies from tissue to tissue inside the same tree from 8-12% in actively growing shoots, from 4-6% in young leaves, and 4-5%, in young pods and seeds. These mounts of mimosine enable *Leucaena* cultivars to show different levels of resistance (Norton *et al*., 1995; Shelton and Jones, 1995), as well as tannins protect plants from psyllid attack, but the immediate mechanism for psyllid resistance in some leucaena species still need further studies to be understood (Griffith, 1991; Wheeler *et al*., 1995).

Therefore, psyllids resistance in Leucaena accessions is generally related to high tannin and fiber contents in Australia (Elder *et al*., 1998; Shelton and Jones, 1995), because psyllid-tolerant species such *L. pallid* and *L. diversifolia* contain high levels of tannins and fibres than the susceptible *L. leucocephala* (Shelton and Jones, 1995). There isn't a wide variation between accessions within a species in tannin content (e. g. *L. diversifolia*), but tannin content vary throughout the year within an accession, and the varieties which have high content of tannins such as *L. lanceolata* shows different levels of resistance and wasn't vulnerable to psyllid infestation, but in case of *L. collinsii*, which has a little tannins content shows moderate or high susceptibility to psyllid attack in Vietnam (Wheeler *et al*., 1995).

Leucaena species and variety selection

Few studies included details in using techniques for pests and diseases control (Schroth *et al*., 2000). Most of researches results indicate that psyllid infestation problems were particularly severe for the narrow genetic base of different leucaena accessions (Rao *et al*., 2000). Therefore, responses of *Leucaena* sp. toward psyllid infestation are varied from highly susceptible to highly resistant (Mullen *et al*., 1998). The apparent resistance between psyllid and Leucaena was investigated in some Leucaena varieties (Finlay-Doney and Walter, 2005), and several Leucaena accessions (Ibrahim *et al*., 1998, Jones; 1998, Mullen and Shelton, 1998).

In general, *leucaena* species are equally vulnerable to psyllid infestation because of the narrow genetic base of the 'Hawaiian-type' stocks that comprised most stands in Hawaii (Morris, 2000; Olckers, 2011), but it was found during a complete range study of psyllid responses to different Leucaena species that the highly resistant species were (*L. collinsii subsp. collinsii*, *L. conferticapitula*, *L. esculenta subsp. esculenta and L. matudae*) and the highly susceptible were (*L. leucocephala and L. multicapitula*), with considerable variation, both between and within species (Shelton *et al*., 1998). The best traits of all leucaena commercial varieties in The United States of America was Wondergraze combines for its excellent growth under psyllid insect attack (Lawrie, 2010). However, in Hawaii results of crossing *L. leucocephala* with *L. pallida* produced a resistant hybrid (KX2- Hawaii) tolerates cool weather, has psyllid resistance, and low mimosine content by (Shelton, 1998, Tim, 2009). Therefore, it was confirmed that, KX2-Hawaii was resistance for psyllid by the Australia Council of International Agricultural Research (Mullen and Shelton, 1998; Shelton and Brewbaker, 1994; Brewbaker, 2008). The experimental trials for introducing a resistant *Leucaena* sp. was conducted in Queensland, when psyllid resistance genes have been moved from *L. pallida* into an elite *L. leucocephala* intraspecific hybrid through a process of cross pollination and repetitive backcrossing. Then, the variety exhibits high levels of resistance to psyllid damage. Also, there are a relationship between psyllid resistance and the volatile substance (Caryophyllene) in three species of Leucaena (*L. leucocephala*, *L. pallida* and their hybrids) in Queensland, (Finlay-Doney and Walter, 2005). The difference between three varieties when caryophyllene proportions dropped dramatically was significant. Another study on resistant accessions, elsewhere in Australia, reported that Tarramba (K636) was the least resistant cultivar of any of *L. leucocephala* cultivars, as there is no evidence that the new cultivar Tarramba (K636) was more psyllid resistance than other commercial *L.*

leucocephala cultivars (e.g. Cunningham and Peru). This contrast with the results of (Bray, 1994; Gieger *et al*., 1995) who used damage rating in their assessment method. The lake of Tarramba (K636) resistance returns to its greatest ability to growth by lateral branching, this observation indicates that Tarramba can be severely attacked by psyllid in coastal central Queensland. Cunningham variety is a well adapted to the dry seasonally tropical environment under heavy attacks of psyllids, because it has high leaf: stem ratio and high leaf density and should be considered as a useful parent for crossing with other species to produce adapted, psyllid-tolerant and nutritious hybrids in Australia (Jones, 1998; Jones *et al*., 1998) whom stated that, Cunningham variety gave higher steer gains and psyllid-resistant and showed more psyllid tolerant than cv. Tarramba. Nevertheless, the magnitude of the superior steer performance on cv. Cunningham was greater in the absence of any psyllid damage. Good resistance was also found in some, but not all, accessions of *L. collinsii*, *L. pallida* and *L. trichanadra*, unfortunately, there was no evidence of resistance in *L. leucocephala* although there was variation in degree of susceptibility, and the mechanisms of psyllid resistance in Leucaena remain unresolved (Shelton *et al*., 1998). The serious damage of psyllid occurred in the susceptible lines with large infestation differences among *Leucaena* accessions the most tolerant lines were *L. trichandra* OFI 53/88, CPI 46568; *L. diversifolia* CPI 33820; *L. esculeuta* OFI 47/87; *L pallida* CSIRO composite, OFI 79/92, and the *L. pallida* x *L. leucocephala* hybrid UQ118. At these times, the two *L. leucocephala* cultivars were severely affected, with cv. Cunningham the most susceptible accession, having scores 1 to 2 units higher than cv. Tarramba, in Australia by (Jones, 1998).

CONCLUSION

This review discusses the findings of the existing researches about Leucaena psyllid, *Heteropsylla cubana* Crawford (Homoptera: Psyllidae) partly in the tropical regions in order to protect the most important forage tree, *L. leucocephala* which play a valuable role in the world of agriculture over a long period of time due to their multifaceted value, increasing and diversifying use of this wonderful species. However, the future use of *L. leucocephala* is in dangerous for the invasion of psyllids. On an optimistic view, several observations worthwhile remembering according to the discussed researches. Firstly, the use of biological control agents predators, parasitoids and entomopathogens in order to increase populations of natural enemies is required. The adults of the predator *C. coeruleus* greatly contributed to population reduction of psyllid in many localities, 20-30 adults per tree consumed 10.630 eggs and 3.500 nymphs of psyllids during their lifetime. Furthermore, using parasitoids such as *P. yaseeni* has firmly established and widespread in all areas with significant results during the season of psyllid's peak. Additionally, the epizootics of entomopathogenic fungi caused significant reductions in psyllid populations (91% mortality), and 82% of reduction in psyllid populations occurred during heavy infestations after applying the fungicide of *Beauveria bassiana* for biological control. Secondly, using the resistant hybrids with taking in consideration the amounts of leaf chemical composition content for each hybrid, especially tannin content which decreases psyllid numbers. Thirdly, planting the suitable cultivar or hybride under the optimum climatic factors as climatic conditions have the authority affect on psyllid population dynamics.

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