Farmers' Knowledge and Perceptions on Management of *L. Invasa* on *Eucalyptus* Species in Western Kenya

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Abstract

Leptocybe invasa, Fisher & LaSalle, (Hymenoptera: Eulophidae) locally termed as Blue-gum Chalcid (BGC) is a gall-forming wasp, which causes an extensive damage to *Eucalyptus* by forming typical bump-shaped galls on tree canopy, specifically on the leaf midribs, petioles and stems of new growths. A study aimed at providing information necessary for sustainable management of BGC, through documenting farmers experiences on BGC attack and their coping strategies, was carried out in five districts of Western Kenya. It involved collection of primary data through pre-tested questionnaire administered to 100 farmers randomly selected from lists of *Eucalyptus* farmers in the five districts to ascertain farmers' experiences on BGC attack and coping strategies. The data was analysed using descriptive statistics based on percentage frequencies of various responses and Chi-square tests for checking the association among the variables. Pearson correlation was used to check interrelation among variables. It was observed that many farmers had observed the symptoms of BGC infestation but few of them were aware of the causative agent. The level of damage was significantly negatively correlated with age of the tree (*Pearson* correlation = -0.657, $p<0.01$) where trees less than 1 year old were highly attacked as compared to trees older than 5 years. Effects of BGC damage on the host tree included mainly deformity and reduced the growth rate of the *Eucalyptus* trees. Majority of the farmers cited lack of know-how on the control methods and the knowledge of the pest to be among the constraints in managing the spread of the pest. Information on the pest status, level of damage by BGC and its control measures should be communicated to the farmers to enhance better understanding, hence improve their perception on management of this pest. Most farmers are still willing to plant more *Eucalyptus* trees irrespective of the pest.

Key words: *L. invasa*, Blue gum chalcid, management, *Eucalyptus*, Farmers' experiences.

Résumé

Leptocybe invasa Fisher & LaSalle, (Hymenoptera: Eulophidae) localement nommé chalcidien bleu à résine (BGC) est une sorte de petite guêpe qui ravage des étendues d'eucalyptus et provoque la formation de nodules typiques sur la couronne des arbres, spécifiquement sur la nervure principale des feuilles, les pétioles et les jeunes tiges en formation. Cette étude conduite dans cinq districts de l'ouest du Kenya avait pour objet de recueillir des informations nécessaires pour la gestion durable de BGC, en se référant aux expériences paysannes sur l'attaque de BGC et leurs stratégies d'y remédier. L'étude s'est basée sur les données préliminaires recueillies à l'aide d'un questionnaire qui a été d'abord testé et administré ensuite à 100 paysans choisis aléatoirement sur des listes de paysans qui ont des eucalyptus dans les cinq districts, afin de connaître leurs expériences sur l'attaque de BGC et leurs stratégies d'y faire face. Les données ont été analysées en utilisant des statistiques descriptives basées sur les fréquences des pourcentages de divers réponses et par le test Chi-carré pour vérifier l'association parmi les variables. La corrélation de Pearson a été employée pour vérifier l'interdépendance existant au sein des variables. On a remarqué que la majorité de paysans avaient observé les symptômes des dégâts de BGC mais peu d'entre eux en connaissaient l'agent causal. Le niveau des dégâts a été sensiblement négativement corrélé avec l'âge de l'arbre (corrélation de Pearson = -0,657, $p< 0,01$) où des arbres âgés de moins d'un an étaient fortement attaqués par rapport aux arbres âgés de plus de 5 ans. Les effets des dégâts causés par le BGC sur l'espèce hôte incluaient la déformation et la réduction du taux de croissance des arbres d'eucalyptus. Parmi les contraintes pour lutter contre l'expansion du parasite, la majorité des paysans ont cité qu'ils ne connaissaient pas les méthodes de contrôle et l'identification du parasite. L'information sur le statut du parasite, le niveau des dégâts infligés par BGC et les mesures pour son contrôle devraient être communiqués aux paysans afin d'accroître leur compréhension et améliorer leur perception sur la gestion de ce parasite. La plupart des paysans veulent bien continuer à planter plus d'arbres d'eucalyptus indépendamment de l'invasion du parasite.

Mots clés : *Leptocybe invasa*, chalcidien bleu à résine, gestion, *Eucalyptus*, expériences paysannes

Introduction

Leptocybe invasa (Hymenoptera: Eulophidae) is a gall-forming wasp locally termed as Blue-gum chalcid (BGC). Its origin is believed to be from Australia, the native country of *Eucalyptus* species. Most of the members of this super family Chalcidoidea are known to be beneficial insects. They are mostly natural enemies of other insect pests, thus Blue-gum chalcid is a unique member of this group of insects as it is a pest of economic importance.

Leptocybe invasa was first recorded in Kenya in November 2002 in the Western Kenya region. It was noted mostly attacking *Eucalyptus* species like *Eucalyptus camaldulensis, E. grandis* and *E. saligna.* Surveys carried out by KEFRI in the year 2003 revealed that the pest invaded Kenya from Eastern region of Uganda (Mutitu, 2003). The pest spread from the border districts of Kenya and Uganda into Western highlands of Kenya. By May 2004, the pest had spread to districts like Busia, Vihiga, Kisumu, Nyando, Butere–Mumias, Bungoma and Teso.

This gall-forming wasp attacks mostly the young seedlings and saplings of up to five years old. However, trees of even ten years old in the field have been observed with the symptoms of attack (Mutitu *et al.*, 2004). This shows that it is mostly the host nursery seedlings that are threatened by the pest. It causes damage to young seedlings/saplings of *Eucalyptus* by forming typical bump-shaped galls on the leaf midribs, petioles and stems of new growth of several *Eucalyptus* species. On heavily infested host plants, galls are found on lateral and terminal growing shoots. Repeated attacks leads to twisted and knobbed appearance of the leaves and the terminal leader shoot degenerates into a lateral shoot causing canopy to be umbrella-shaped. This leads to a deformed plant. On older infestations, it is possible to observe holes. These are adult emergence holes. The plants also show stunted growth.

Eucalyptus species are widely grown as exotic trees in plantations in major agro-ecological zones in Kenya. The only records shows that the Forest Department manages about 15,000 ha. while the privates users grows over 35,000 ha., of which small-scale farmers grow about 35% (ISAAA, 1995). The hectarage under this species is at present estimated to be ten fold of this available statistics.

Materials and Methods

The study was carried out in five Districts of Western Kenya namely: Bungoma, Busia, Nyando, Nandi, and Vihiga that had been infested for some time. These districts belong to two agro-ecological zones namely, AZ2 and AZ3. The study involved collection of primary data through carefully designed and pre-tested questionnaires that were administered to 100 randomly selected *Eucalyptus* farmers in the five districts. Multi-stage sampling techniques were employed following stratified, systematic and simple random procedures in obtaining 100 respondents who represented farmers with at least 100 host trees in their farms. The interviews were conducted in the farmers' local languages and their responses were carefully translated and recorded in English. This was achieved by hiring research assistants who were fluent in official, national and local languages in both districts. Most of the questions in the questionnaires were open ended to ensure that farmers' views were not limited. The questionnaire consisted of four sections as follows; (i) general information on respondent in which education level, time spent on farm, sex of head of household, location, district and province were obtained (ii) cultivation of *Eucalyptus* in which number of *Eucalyptus* on farm, year planted, methods of establishment, mortality of *Eucalyptus*, technical advice, reasons for growing *Eucalyptus* and problems encountered were obatined (iii) awareness on *L. invasa* infestation and practiced methods of control and (iv) farmer's future plans on expanding growing of the host tree.

Descriptive data analysis, based on percentage frequencies for all sections in the questionnaire, was used. Chi-square tests were used to check the association on awareness and infestation variables, methods used in control variables and some general characteristics of the respondents. Pearson correlation was also used in checking the inter-relationships between the variables that were hypothesized to be associated within each other. Among these factors were age of the trees and level of infestation, education level of the respondent and awareness, management, methods of control, the level of infestation and other household characteristics (time spent on farm and gender). All statistical analyses were carried out using Statistical Package for Social Scientists (SPSS), release 12.0 for Windows whereas MS-Excel spreadsheet package was used in data management procedures.

Results

Ninety one percent (91%) of the farmers interviewed were male while (9%) were female. Plantation/wood-lot owners who were on farm full-time were 45% while 55% were part-time. Majority of the farmers interviewed had at least attained primary (37%) and secondary (38%) education while those with higher Secondary education, Diploma/certificate and University education being 6%, 8%, and 9%,

respectively. Those with no formal education were 2% of the total households interviewed.

Most of the land (62%) in the region under *Eucalyptus* was inherited while 36% was purchased. Two percent of farmers had their plantation on land that was partially inherited and purchased.

Most plantations/wood-lots (36%) had trees/seedlings population of over 2000 regardless of the species. Twenty four (24%) of the farms had a population of between 100-500 while the farms with tree population of between 500-1000 and 1000-2000 were 22% and 18%, respectively.

Most of the *Eucalyptus* farmers (65.7%) preferred *shamba* system to establish their plantation while 31.3% of the farmers planted on grassland. Boundary or line hole planting (2.0%) was the method least used in establishing *Eucalyptus*. Severity of infestation was not significantly ($p = 0.48$) related to the method of *Eucalyptus* establishment.

Most respondents (65%) rated mortality of *Eucalyptus* in the last one year to be low (20% of trees dead). Twenty five (25%) rated mortality to be moderate (20-50% trees dead) while 2% and 8% rated to be none and high (more than 50% trees dead), respectively.

The major challenges of *Eucalyptus* growing in Western Kenya include pests and diseases, lack of quality planting material, lack of technical advice and scarcity of land and finances (Table 1).

Table 1: Major problems farmers are facing in *Eucalyptus* growing

Problem	% Response
Pest and diseases	29.8
Lack of money, land and Theft	21.4
Lack of technical advice	18.6
Lack of quality planting material	15.2
Lack of ready market	7.8
Animal destruction	7.1

Most respondents (94%) had observed the symptoms of BGC infestation on *Eucalyptus* but only 12% of them were aware of the causative agent of the symptoms as being mainly insect (80%) or disease or bad planting materials.

The damage was reported to occur mostly during the dry season (74%),wet season (10%), throughout (5%) while 9% of respondents were not sure of the seasonal variation in attack.

Few farmers (18%) claimed to have observed BGC infestation on other tree species and crops.

Effects of BGC damage on the host tree included mainly deformity and reduced growth rate of the *Eucalyptus* trees. It was also reported to cause death of seedlings (Figure 1).

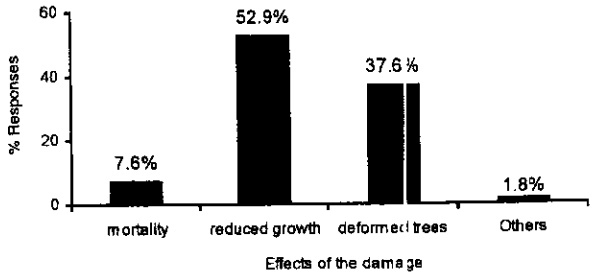

Figure 1: Response on BGC damage effects on the host trees in Western Kenya.

Major causes of mortality of *Eucalyptus* trees in the area of study included drought, termite attack, diseases, fire destruction, animal destruction and other unknown effects (Table 2).

Table 2: Causes of mortality of *Eucalyptus* in the area

Causes of mortality	% Response
Drought	22.2
Termites attack	23.8
Fire	6.3
Disease	24.4
Animal destruction	8.8
Don't know	3.1

There was a significant ($p<0.01$) association between the level of damage and age of the tree where trees that were less than 1 year old were highly attacked as compared to trees older than 5 years. Similarly, there was a significant negative correlation (Pearson correlation = -0.657, $p<0.01$) between the level of attack and the age of the plant (Table 3).

Table 3: Farmers' response on the damage levels on *Eucalyptus* tree/seedling at different ages

Level of the damage	Age of trees (Years)			
	<1	1-3	3-5	>5
Not attacked	2	6	17	38
Low (<20% of trees attacked)	14	26	45	18
Moderate (20-50% of trees attacked)	26	48	10	4
High (>50% of trees attacked)	53	5	4	3

Only 28% of all respondents (45% of those who knew the cause of the damage) made an attempt to control the pest. Majority of the farmers cited lack of know-how on the problem and control methods as

the major setback to implementation of control methods. Other constraints mentioned included lack of knowledge of the pest, lack of money to buy chemicals and lack of interest on the part of some farmers (Table 4).

Table 4: Farmers' reasons for not controlling the *L. invasa*

Reason	Response (%)
Lack of know how on control method	87.8
Lack of money	5.4
Lack of interest	1.4
Cause unknown	5.4
Total	100.0

The farmers had received advice on control methods mainly from foresters, extension officers, friends/ neighbours and KEFRI staff in the area. The advice farmers received on the control methods included planting of resistant *Eucalyptus* species, use of cultural methods, physical and mechanical methods and chemical use (Figure 2).

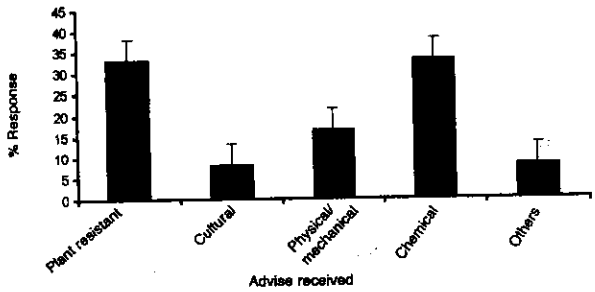

Figure 2. Advice received by the respondents on L. invasa management in Western Kenya.

The control methods employed by the respondents were cultural, physical or chemical and were administered mainly as foliar sprays or in soil. Chemical control was the method mostly used by the respondents in management of *L. invasa* (Table 4). Most of the methods were rated to range from not effective to moderately effective, with only a few being highly effective in the control of the *L. invasa* damage (Table 4).

Table 4: Response on the efficacy of the control methods used to manage L. invasa

	Not effective	Moderately effective	Highly effective	% of Total
Cultural control	4	2	2	36.4
Physical/mech-anical control	1	1		9
Chemical control	4	7	1	54.5
Total	9	10	3	100

Farmers in the region first observed damage effects of BGC as early as year 2000 in Vihiga and Busia. Since then, the pest has spread to the other three districts namely: Bungoma, Nyando, and Nandi (Table 5).

Table 5: The spread trend of BGC in Western Kenya.

Year BGC first observed	Districts
2000	Vihiga and Busia
2001	Vihiga, Busia and Bungoma.
2003	Vihiga, Busia, Bungoma and Nyando.
2004	Vihiga, Busia, Bungoma, Nyando and Nandi

Despite the damage due to *L. invasa*, 57.9% would still advice anyone willing to plant *Eucalyptus* to go ahead while 36.5% of the respondents would want them to seek advice first before planting. However, 4% of the respondents would advice them rather not plant *Eucalyptus*. About 2% of the respondents did not know what advice to give (Figure 3).

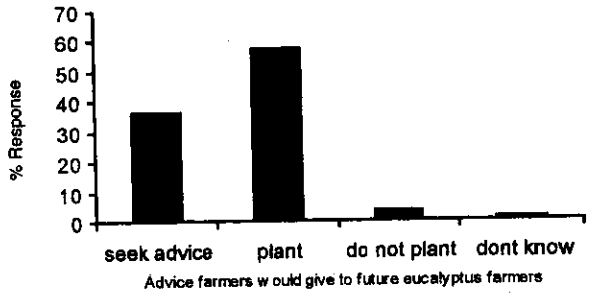

Figure 3: Advice farmers would give to future eucalyptus growers

About 90% of the farmers are still interested in planting *Eucalyptus* in future due to its divergent uses and its fast growing nature. Other reasons why they would want to plant *Eucalyptus* in future is to use them in marking farm boundary, and environment conservation (Table 6).

Table 6: Reasons for growing more *Eucalyptus* in future

Reason	% Response
Fuel wood	18.2
Construction/timber	19.6
Income generation	35.0
Boundary marking	11.2
Environmental conservation	5.6
Fast growing	5.6
Others	4.7
Total	100

About 50% of the farmers are willing to plant between 50-1000 *Eucalyptus* trees, 40% are planning to plant 1,500-10,000 trees while 10% aim at planting over 10,000 trees in the future (Figure 4).

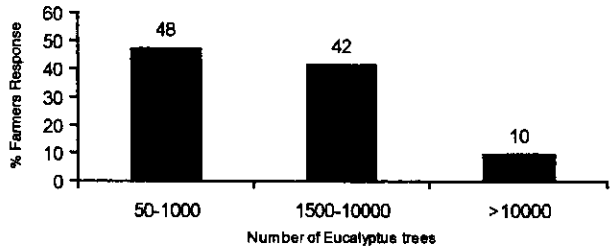

Figure 4: Numbers of trees farmers are planning to plant in future in Western Kenya.

Up to 27% of farmers projected to source their planting materials from own farms while 25% planned to get their planting materials from NGOs and CBOs. Other mentioned sources included neighbours, open market, KEFRI, Forest Department and BAT/MTK (Table 7).

Table 7: Intended future sources of planting material

Sources of planting material in future	% Response
Own farm	27.3
Supply from organisations (NGOs and CBOs)	25.7
Forest department	15.2
Borrow from neighbour	11.4
Buy from open market	11.4
KEFRI	8.3
BAT/MKT	0.8

The farmers who are not willing to plant more *Eucalyptus* in future cited land as the major limiting factor for expansion of *Eucalyptus* growing and *L. invasa*, as a threat to future planting of *Eucalyptus*. Other constraints included lack of planting material, lack of capital, diseases and lack ready market for *Eucalyptus* trees (Figure 5).

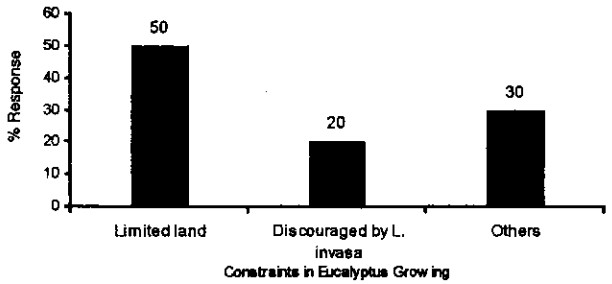

Figure 5: Constraints faced by the Eucalyptus farmers in attempts to expand Eucalyptus plantation in Western Kenya.

Discussion

Farmers in Western Kenya grow *Eucalyptus* mainly for fuel-wood, construction and income generation. Farmers also utilise *Eucalyptus* trees for timber production, environmental conservation and boundary marking of the farms. Other uses include source of shade, medicinal purposes, windbreakers, and for fencing

Most *Eucalyptus* farmers in Western Kenya are willing to plant about ten times the current number of trees they own. This indicates its wide-spread use and high demand for its products confirming the finding by Oballa (2002) that *Eucalyptus* trees are major source of fuel-wood, income generation and in construction in Western Kenya. According to studies done on comparative evaluation of farm forestry enterprise versus maize cultivation in Western Kenya, it emerged that gains were higher under coppices from *Eucalyptus* than maize (Cheboiywo, 2004). This is true for the finding in this study that people are planting *Eucalyptus* mainly for income generation as well as other important uses.

Pressure on farm-land has made most farmers in the region result to *shamba* system as the most preferred method of establishing *Eucalyptus* as it provides additional land for agriculture as well. The method of planting did not influence the severity of BGC infestation on the trees.

The farmers interviewed were not aware of *L. invasa* but they had noticed the damaging effects of the pest, this could be attributed to the conspicuous and severe symptoms of BGC damage. The small size of the pest could be the reason why many farmers could not notice the insect even though the pest was reported by Mutitu (2003) to cause damaging effects to *Eucalyptus* in the region. This also confirms that there is very little information on the ground about the insect pest and the generally low educational background in the region could be a hindrance in accessing the little information disseminated through pest alert leaflets by KEFRI. It was also noticed that over 50% of the farm owners are only on farm part-time and this could be the other reason for low quest for information on the pest and its management options.

Some farmers said they had observed BGC symptoms on cassava, maize, *Lantana camara*, *Cupresus lusitanica* and citrus species. However, the samples observed by the enumerators confirmed that the infestation was not caused by BGC.

The pest problem was noticed as early as year 2000 but was reported to KEFRI only in the year 2002 when more than three districts had been infested. This could be due to the fact that the farmers could not easily understand the loss due to the pest as they

would for crops with shorter cycles. Farmers even cited lack of knowledge of the pest as a major reason for not attempting control. Even those who tried to control did not seem to be aware of the correct methods to employ since most of the methods used were reported to be ineffective in the control of *L. invasa*. Chemical use (mainly as foliar sprays) was one of the mostly favoured control methods using chemicals as confidor (Chloropyrifos), methomex 90 (methomyl 90%), ambush (cypermethrin), dursban, diazinon, dethane and omo (a detergent). Insecticides as carbaryl, pyrethroids, chlorpyrifos, diazinon, dimethoate, malathion have also been labelled for control of gall-forming insects (Lewis and Wintersteen, 1999) and so the farmers seem to have been correctly advised on the chemicals to use. Use of multiple chemicals was a very common practice and so the effectiveness of particular chemical could not be determined.

Several kinds of wasps parasitize gall-forming insects and limit the number of galls formed (Walsh, 1996), and should, therefore, be protected from the chemicals. Adult gall-forming insects leave galls through exit holes. The vacated space is often occupied by small spiders and beneficial insects such as lacewing larvae, ants or parasitic wasps (Walsh, 1996; Drees, 1999). Chemical method of pest control is also very expensive and is favourable to high value crops such as seed stands and orchards if correctly used.

Cultural control methods such as pruning and destroying infested plant parts is an effective, but labour-intensive way to minimise gall problems (Buss, 2003). The farmers were aware that Planting of resistant species could provide a solution to the pest problem and so host plant selection is the sure direction to take.

The effects of *L. invasa* infestation have been shown to include plant deformity, reduced growth and dieback of *Eucalyptus spp.* The pest damage was reported to occur mainly during the dry periods and so death of plants reported by some farmers, to result from BGC infestation, could be a result of compounded effect of termite attack and drought since drought, termite attacks and diseases are other major causes of mortality in *Eucalyptus* in Western Kenya. Drought increases water loss through evapo-transpiration leading to wilting and subsequently death of trees. Termites are tropical pests and attack mainly young exotic trees (Harries, 1971).

Eucalyptus trees under five years were seen to be more susceptible to *L. invasa* attack than older trees. This could be associated to a finding by Mendel *et al.* (2004) that young plants/seedlings of *Eucalyptus* have tender parts making them favourable for insertion of eggs by adult wasp. Young plants also have more meristemtic growth sites, which are favourable for development of *L. invasa*.

The fact that farmers are still willing to increase *Eucalyptus* plantations in future despite damage by *L. invasa* and other constraints indicates the economic importance of *Eucalyptus* tree. The major targeted suppliers of the planting material are on-farm, Organisations (NGOs and CBOs) and the Forest Department. Some farmers are intending to borrow from neighbours, buy from open market and KEFRI.

Poor Information dissemination in forestry attests to the fact that very few farmers had received advice on the management of the pest from the forest department.

A few farmers are, however, not willing to plant again mainly due to limited availability of land. This indicates the infestation, though causing a lot of worry does not have a negative impact on *Eucalyptus* growing.

Conclusions and Recommendations

Information on pest biology and its control measures should be provided to the farmers to enhance better understanding of the situation. Information on the pest status and level of damage by *L. invasa* should be communicated to the farmers and relevant authorities to alleviate the panic and satisfy the curiosity that exists with the farmers.

The control measures currently being employed in the management of *L. invasa* include cultural, mechanical and chemical methods, which are mostly not effective or are less effective. Research should be carried out to come up with new or more effective versions of the commonly employed methods.

Farmers are advised to use recommended short-term solutions to contain the damage by the pest as studies are still underway to research and implement long-term solutions, which include resistant hosts and Classical Biological Control (CBC). The use of chemicals as a method of control is expensive and not sustainable. More effort is needed to identify resistant *Eucalyptus* species, provenances and clones.

Since farmers seem to look for quick solutions to the pest problem, screening of the locally available systemic insecticides need to be carried out and the information disseminated to the farmers.

Better and reliable seed and seedling sources should be established country-wide to ensure availability of quality material to the farmers and also to minimise spread of pests and diseases.

Eucalyptus growing in Western Kenya is faced with many challenges and a package that addresses all these should be provided.

Farmers are still willing to increase *Eucalyptus* plantations in future despite damage by BGC and other constraints.

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