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Sensitization of Eucalyptus Growers on Status of Blue Gum Chalcid, *Leptocybe invasa* Infestation in Kenya

Proceedings of the Blue gum chalcid Leptocybe invasa (Hymenoptera: Eulophidae) workshop held at Bungoma, Kenya, from 21 to 23 March 2006

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Cover Caption
Top: Young plantations of improved *Eucalyptus grandis*
Bottom: Typical Blue gum chalcid galls on Eucalyptus species
Inset: Magnified adult Blue gum chalcid

Photographs by
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Participants of the Bungoma BGC AFORNET Workshop

Abbreviations and Acronyms

AF	Agroforestry
AFORNET	African Forest Research Network
ANOVA	Analysis of variance
ASAL	Arid and Semi Arid Lands
BAT	British American Tobacco.
BGC	Blue Gum Chalcid
CABI	CAB International
CBC	Classical Biological Control
DBH	Diameter at Breast Height
DFO	District Forest Officer
EAAFRO	East African Agricultural and Forestry Research Organization
FAO	Food and Agriculture Organization
GMO's	Genetically Modified Organisms
ICIPE	International Centre for Insect Physiology and Ecology
ICPM	Interim Commission for Phytosanitary Measures
ICRAF	International Centre for Research in Agroforestry
IPM	Integrated Pest Management Kenya Forestry Research Institute
IPPC	International Plant Protection Convention
ISAAA	International service for the Acquisition of Agro-Biotech Applications
ISPM	International standards for phytosanitary measures
KARI	Kenya Agricultural Research Institute
KEFRI	Kenya Forestry Research Institute
KEPHIS	Kenya Plant Healthy Inspectorate Service
KSTCIE	Kenya Standing Technical Committee for Imports and Exports
MAI	Mean Annual Increment
NBC	National Biosafety Committee
NEMA	Natural Environmental Management Authority
NGO	Non-governmental Organization
PFO	Provincial Forest Officer
PIP	Plant Import Permit
PLA	Pest Leaflet Alert
RCD	Root Colour Diameter
SED	Standard Error Difference
SPS	Sanitary and Phytosanitary Measures
TBP	Tree Biotechnology Project
WTO	World Trade Organization

Speech on the occasion of the official opening of the AFORNET Workshop on Blue Gum Chalcid, held at Bungoma from 21 to 23 March 2006

Dr. M. N. Muchiri, Assistant Director,
Forest Plantations Programme, KEFRI

The District Forest Officer Bungoma,
Distinguished guests,
Workshop participants,
Workshop organizers,
Ladies and gentlemen,

Good morning.

I am pleased to be here today at the start of the AFORNET (Africa Forest Research Network) workshop on the Blue Gum chalcid (BGC). I warmly welcome you to the workshop. Mr. Chairman, this workshop has been organized to provide a forum to exchange ideas on the management strategy of the BGC which has attacked the Eucalyptus trees in Western Kenya.

Ladies and gentlemen, Eucalyptus are the most grown trees in Kenya and there are over 90 species and 20 hybrids in the country. Of these, 12 are widely grown in Kenya. The most popular is *Eucalyptus camaldulensis, saligna* and *grandis* and are all widely grown in Western Kenya. Unfortunately, it is these species that the blue gum chalcid has chosen to attack.

Mr. Chairman, the eucalyptus tree plays a very important role in the lives of the people of Western Kenya. They provide raw materials for construction, fuelwood fibre products such as paper, and many other goods and services needed to improve human welfare. Nearly 95 % of energy needs by the rural population, 30% of the pulpwood and 80 % of the energy consumption by tea factories is from eucalyptus trees. This is because; the cost of alternative fuel is about four (4) times more than burning eucalyptus.

As you are aware, nearly 90 % of trees grown in Western highlands of rift valley are Eucalyptus. Unfortunately, Kisii, which forms the cradle of the eucalyptus in Kenya, has come under the BGC attack. Recently the attack has also been reported in the coastal region, 1000 km away from the initial attack area.

Mr. Chairman, following the report that Uganda has also had the attack, effective control of the pest strongly calls for collaboration between the East African countries. At the global level, Kenya is working with Israel and has made contact with Morocco, Iran and Australia, which are the other countries where the pest has been sighted.

Ladies and gentlemen, immediately the BGC was first reported in the country, a KEFRI team of entomologists was sent out to identify the problem and assess the damage. This was done promptly and an alert sent out immediately through brochures and newspapers. A video was also made and is available on computer CD.

The next step was to train forest officers in western Kenya and other parts of Kenya on pest identification and assessment of damage on host trees. This was done through another workshop that was previously held in Busia in November 2004. We continue to provide the relevant information to forestry section stakeholders through a forum like this and others organized by the Tree Biotechnology Project service provider workshops.

As a beneficiary, the farmer is an important factor in all the strategies we adopt. It is the farmer who plants the tree, tends, harvests and utilizes the produce. If our methods are user friendly, the farmer will plant more trees and diversify his stocks.

If we fail to put farmers on board, our efforts may amount to just another wasted effort.

Ladies and gentlemen, diversity of species may not be the main focus of this workshop. However, while testing for resistance to attack through breeding we are also looking at resistance between species. This requires diversity and within the Eucalyptus family, we have 70 species and 20 hybrids to try out. The strategy is to try out as many species and hybrids as possible became BGC is a fairly new pest, which needs to be tested on a wide range of eucalyptus trees. While on diversity, it might also be important to think of other tree species. Many of our farmers usually plant exotic species because nobody has told them about the growth performance of the local species when properly tended. Indeed every locality in Kenya has the best alternative tree species that can be planted and used by the communities to reduce dependence on exotic trees.

Finally, ladies and gentlemen, I would like to thank you all for turning up for this important workshop. It is a mark that you value your country and your trees. I sincerely urge you to freely exchange information and discuss all the possible management options relating to the blue gum chalcid with a view to coming up with workable management strategies. I look forward to receiving a copy of your recommendations.

With these remarks, it is now my pleasure to wish you fruitful deliberations and to declare the AFORNET BGC information exchange workshop officially opened.

Thank you and God bless us.

Status of Eucalypts in Forestry Systems In Kenya

O. Oballa and L. Wamalwa
Kenya Forestry Research Institute

Introduction

Eucalypts were introduced to Kenya in 1902. The aim of the initial introductions was to identify fast growing tree species to supply wood fuel for the Kenya – Uganda railways. To date 90 species and 20 hybrids of eucalypts have been introduced to Kenya (Oballa, 2002). The uses of eucalypts have since then increased and they are grown for timber, plywood, power and telephone transmission poles, pulp, building and fencing posts, rails medicine, honey, tannin, perfumery and environmental enhancement.

Eucalypts are grown widely in most major agro-ecological zones because of their species diversity. It is estimated that, 15000 ha of eucalyptus are grown by Forest Department, 35 000 ha by Private Sector, comprising mostly of major cash crop production estates such as Brooke Bond, James Finlays Ltd, Eastern Produce, Kakuzi and BAT Ltd. Unknown hectares are owned by small-scale farmers, urban and county councils in the form of woodlots, ornamentals, boundary planting, avenue plantings and scattered trees on farms and grazing lands. Eucalyptus is the third widely planted genus in Kenya after Pine and cypress.

Most of the total area under eucalypts is dominated by three species, namely: *E. grandis*, *E. saligna*, and *E. camaldulensis*. A few hectares are under *E. africana*, *E. paniculata*, *E. tereticornis*, *E. maculata*. *Eucalyptus regnans*, *E. fastigata* and *E. botryoides* though successful, have remained in experimental plots. Some clonal hybrids introduced from South Africa have also gained popularity. A trial of the three species at Londiani attained a mean diameter at breast height (DBH) and height of over 17 cm and 28 m, respectively in 15 years (Konuche, 1989).

This paper aims at highlighting the status of eucalypts: the successes and the challenges that need to be addressed. It is envisaged that the genus will continue playing a major role in the development of the forestry sector both at farm and industrial level.

Productivity of eucalypts

The popularity of eucalypt with tree growers may be attributed to some of the characteristics of the planted species. Such characteristics include seed fecundity; ease of propagation, fast growth, coppice ability and less susceptibility to pests and diseases.

The widely planted eucalypts are regular and prolific producers of seed ranging from 160 000 to 3 000 000 kg^{-1} (KEFRI, 2004). The seeds once processed and sown fresh under the right conditions for germination can attain up to 90 % viability. With good nursery practices, most eucalypts only require only three months before planting out in the field. This makes it attractive to small-scale private nursery developers as the cost of maintenance in the nursery is affordable and the infrastructure is less elaborate.

The widely planted *Eucalyptus* species are faster in growth performance when compared to other tree species. Most of these eucalypts can attain a mean annual increment (MAI) in height of over 2 m. The total volume over the years has improved from approximately 20 $m^3ha^{-1}yr$ to 70 $m^3ha^{-1}yr$ (Webb *et al.*, 1980; Oballa and Giathi, 1996; Brooke Bond, 2002 unpublished Report). Eucalypts are favored by growers because of their ability to coppice and yield the products for many rotations without deterioration in vigour. Kaumi (1983) indicated that up to four rotations of six or more years could be harvested from the same stump with the highest yield realized in the second and third rotations. That means a farmer is able to harvest poles or post for nearly 50 years after planting the first crop.

Another important trait of most eucalypts favored by farmers is its unlikelihood to become weedy. Eucalypts seed germinate but in most cases, they are so delicate that unless the conditions are favourable, they die. The rare natural regeneration by a eucalypt has been observed near Mau summit and in Timboroa. The exact species identity is still to be established.

From the time of their introductions, eucalypts have been inflicted by only a few cases of pest and disease outbreaks. The earliest outbreak was that of snout beetle (*Gonipterus scutellatus*) in 1920s, which largely affected *E. africana* and other 26 species but was effectively controlled by *Anaphes nitens* (Griffith and Howland, 1962). The recent outbreak of Blue Gum Chalcid (*Leptocybe invasa*) is the next large-scale pest ever experienced in the country. The pest has been observed mainly on *E. grandis*, *E. saligna* and *E. camaldulensis* in Western Kenya. Strategies for its management form a major discussion agenda for the workshop.

The environmental challenges of eucalypts

Eucalypts have sometimes faced unnecessary political over-tones and social upheavals ending in uninformed decisions. For example, most of us will remember the mobilization of people to uproot eucalypts by the Presidential Commission on Soil, Water Conservation and Afforestation in the mid 1980s. The vilification of eucalypts is not restricted to Kenya but has echoed in many countries such as S. Africa and India (Calder, 1989). The greatest concern has been on water consumption, nutrient up-take and reduction of biodiversity by eucalypts. Research has been initiated in various organizations to determine the scientific value of claims on eucalypts over water use, nutrient up-take and biodiversity. Table 1 and 2 below show the interception of rain by various forest cover and potential water consumption by various tree species, among them eucalypts. Eucalypts allow more rainfall i.e. 88.4 % to reach the ground as compared to Teak (79.2 %) and *Pinus roxburgii* (77.9 %). under controlled conditions *Eucalyptus* hybrid had the highest productivity per litre of water of 2.06 g compared to *Syzigium cumnii* (2.00 g) and *Albizia lebbeck* (1.83 g).

Table 1. Rainfall interception by forest cover*

Species	Stand density, trees ha^{-1}	Percent of rainfall			
		Through fall	Stem flow	Through fall & stem flow	Interception loss
Eucalyptus hybrid	1658	80.75	7.69	88.44	11.56
Shorea robusta	1658	66.4	8.3	74.7	25.3
Alstonia scholaris	668	54.6	7.2	61.8	38.2
Pinus roxburghii	1156	74.3	3.6	77.5	22.1
Tectona grandis	742	73.2	6.0	79.2	20.8
Acacia catechu	574	67.3	4.2	71.5	28.5

*Source:Tiwari and Mathur, 1983

Studies within the James Finlay Ltd estates at Kericho indicate that, eucalypts use a lot of nutrients, when at the peak of their growth. Clear felling at that period of maximum growth results in removal of a lot of nutrients and moisture still held in wood. However, harvesting after that peak period result in better management since trees have started returning nutrients pumped from deep soils onto the ground layer. Further research has indicated that areas under eucalypts have high level of micronutrients when compared to those under old tea crops. Similarly, run-offs are also higher under closed canopy tea plantations than under eucalypts. It is from these studies that the tea estates have kept a policy of retaining a 75 m belt on both sides of river/stream banks under natural forest to help in improving water filtration, species diversity and reducing run-offs that could lead to heavy soil erosion.

Table 2. Potential water consumption*

Species	Total biomass produced per l of water, g	Water consumed per gram of biomass, l
Acacia auriculiformis	1.39	0.72
Albizzia lebbeck	1.83	0.55
Dalbergia sisoo	1.31	0.77
Eucalyptus hybrid	2.06	0.48
Pongamia pinnata	1.13	0.88
Syzigium cuminii	2.00	0.50

*Source :Tiwari and Mathur 1983

The issue of low diversity of plant species under plantations of eucalypts can be accepted and considered a normal phenomenon under all monocultures. First, the land preparation practices are geared towards eliminating interference and competition from other species. Second, it is usual that a species community usually tends to develop survival strategies to edge other competitors and eucalypts are no exception. Thus, only a few plant and animal communities that can tolerate or derive mutual benefits can be associated with them. An interesting observation has been recorded from the tea estates where less productive tea areas were to be planted with eucalypts on the understanding that the eucalypts will suppress the tea and eventually wipe them out. The tea bushes have instead continued to flourish and yield averagely well under the eucalypts.

Eucalypts and poverty alleviation

Several factors support the growth and spread of eucalypts in Kenya. First is the diversity of eucalyptus species adapted to variable ecological zones? Second, the poor state of forest resources in Kenya requires availability of fast growing trees that can meet the deficit, and here eucalypts comes in handy. Third, the realization by the public that there is a market in the region Table 3 and eucalypts can be grown as a cash crop. Fourth, the recent efforts on species genetic improvement and development of better seed sources (KEFRI Annual Report, 2001) and re-introduction of clonal technology followed by the development of infrastructure for clonal multiplication (ISAAA Annual Report, 2002) have given the public a new impetus to grow eucalypts, especially in the traditional eucalypt zone of Western Kenya. Improvement in technology of handling eucalypts is also being observed on the area of timber sawing, charcoal production and treatments of poles and posts.

Table 3. Potential markets for wood products in various consuming sectors*

Sector	Tones per year
Firewood	30 000 000
Industrial logs	500 000
Tea Industry KTDA	155 000
Tobacco curing	78 000
Bricks curing	56 000
Fish smoking	18 000
Bakeries	94 000
Restaurants/kiosks	5 500 000
Private / Public institutions	250 000
Total estimate	36 651 000

*Source:Ngibuini, 2004

The current trend of those desiring to grow eucalypts is not just to meet their domestic needs and address environmental concerns but also to raise incomes from the lucrative market. Large estates such as Kakuzi and James Finlay Ltd are already supplying some volume of timber, poles and posts to the market. The small-scale growers are also not left behind and have continued to dominate the market for low processed products such as rails, rafters and posts in markets such as Kondele in Kisumu and Kawangware in Nairobi. The three last products are dominantly from Eucalypts.

Way forward

From the above, only threat to wide-scale planting of eucalypts seems to be the spread of Blue Gum Chalcid. The following strategies could be considered to reduce the threat and keep eucalypts on the economic vicinity:

- Research on biological control measures for long-term management.
- Move the lesser planted species to the forefront if not affected.
  - For lowlands: *E. urophylla, E. paniculata, E. maculata* and *E. citrodora*
  - For Highlands: *E. africana, E. regnans, E. fastigata, E. crebra, E. nitens.*
- Select pest tolerant varieties for multiplication;
- Species diversification with less planted indigenous and exotic tree species such as *Maesopsis eminii, Milicia excelsa, Casuarina* sp. African acacias, *Markhamia lutea albizia* sp. And *Juniperous procera* in the lowlands and *Podocarpus* sp. *Vitex keniensis, Prunus africana* and *Polysius kikuyensis* in the highlands, among others; and.
- Proper selection of sites and designs for species establishment that will have less negative environmental impacts, i.e. mosaic planting of eucalypts together with agricultural crops and indigenous trees.

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The Status of Eucalypts Clones and Hybrids in Kenya

M.N. Muchiri
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Importance of forests

- Forests provide habitat to the country's wildlife and ecological stability, particularly in water catchments and wetland areas; and
- Support agriculture, hydro electricity generation through conservation of water catchments, water flow regulation, preventing soil erosion and siltation of dams and rivers; and
- At global level forests provide public goods in form of biodiversity values, ecosystem interdependency, linkages and carbon sequestration as well as being a rich reservoir of research material and medicinal plants

Major problem facing forests

- Forests are overexploited for industrial and domestic wood supply, fuel wood, fodder, medicines and fruits; and
- Rural communities are often forced by poverty and population pressure to over exploit natural forests and trees on farm to cater for their livelihoods, and in Arid and Semi Arid Lands (ASALs) they use crop residues and cattle dropping for energy, thus reducing soil fertility and overall land productivity

Possible solution

- Rural communities can lessen the impact on natural forests by including trees in farming systems as well as enhancing afforestation by growing superior trees through adoption of appropriate technologies
- Adopt clonal forestry and vegetative multiplication, which has the potential to grow more trees with desirable traits and ensure retention of the same.

Tree Biotechnology Project (TBP)

- Started at Karura in 1997 by KEFRI, Forest department, Mondi Paper company of South Africa and the International Service for the Acquisition of Agro-Biotech Applications (ISAAA);
- Provide superior clonal material to both rural and urban communities in the country to mitigate wood deficiencies and especially woodfuel;
- Contribute to improved living standards by enhancing forestry through integrating successful proven forestry biotechnologies into the traditional propagation systems, higher productivity and use of marginal lands for forestry; and
- Have a multiplier effect of conservation of indigenous natural forests' biodiversities by reducing exploitation pressure, which is in line with the government *Economic Recovery Strategy for Wealth and Employment Creation.*

Species promoted by TBP

- GC clones from South Africa, across between *E.grandis* and *E. camaldulensis.* The GC is characterised by wood of high density and high calorific value.
- *E. grandis* x *E. urophylla* (GU), *E. grandis* x *E. nitens* and clones of *E. grandis* under the signed Material Transfer Agreement with Mondi Business Paper.
- Local Eucalyptus (*E. tereticornis, E. saligna, E. grandis and E. camaldulensis*), *Grevillea robusta* and *Melia volkensii*

Production capacity

- By the end of December 2005, 63 045 ramets had been put on hedges at Karura on a 3.0 ha plot;
- Annually, the hedges now produce 6 052 320 of placed cuttings and 3 026 160 rooted plantlets at 50 % root strike;
- To ensure maximum growth and production, both plantlets and hedges are irrigated and treated with artificial fertilizers;

- So far no major pest and disease of importance have been noted. However, there are a few leaf defoliators and sapsuckers that were managed using IPM techniques. Nonetheless, the hedges cannot be said to be free of BGC; and
- Regional centres at Meru to serve Mt. Kenya Region, Gede for Coast region and Eldoret to cater for North Rift valley in distribution of clonal materials have been established.

Growth performance of eucalyptus hybrids

KEFRI and Tree Biotechnology Project have established eucalyptus hybrids trial plots at 12 sites in the country (Table 1).

Table 1. Eucalyptus clones and hybrid trial plots

Site	Time established
Karura	April 1998
Embu	May 1999
Machakos	May 1999
Timboroa	July 1999
Gede	June 2002
Msambweni	June 2002
Marigat	May 2002
Londiani	June 2004
Yala	June 2005
Meru North	November 2005
Kabage	2002
Hombe	1999

The individual trees growth performance is assessed on the basis of the following parameters:

- Survival;
- Stem form scoring from 1to 4 (1 being the worst and 4 the best);
- Diameter at breast height, cm;
- Height, m;
- Diseases; and
- Insect.

Embu

- Analysis of data by one way ANOVA at five years of age, showed significant differences in height at $p < 0.001$
- The clones performed better than the local landraces.
- The best clone was GC15 with a mean height of 17.15 m
- The best local landraces was *E. grandis* with a mean height of 14.75 m, which was 14% less than that of the best clone
- There were significant differences in height and DBH in year three at $p < 0.001$ (Table 2a and 2b)
- The best performing clones and species at this site were GC15, GC581, GC14 and GC642. *E. camaldulensis* and *E. tereticornis* did not perform well as they are more adapted to low and warmer sites

Hombe

- At the age of five years, ANOVA showed significant differences in the mean heights at $p < 0.001$
- *E. grandis* had the best average height and DBH of 16.32 m and 18.19 cm, respectively

Machakos

- At five years of age, the ANOVA showed significant differences between the clones and species ($p < 0.001$) in height (Figure 1)

Table 2a. Mean height of Eucalyptus clones and hybrids.

Place on landscape	Sokoke (2 yrs) Se 1.22	Msambweni (2 yrs) Se 0.51	Gede (2 yrs) Se 1.81	Machakos (5 yrs) Se 1.97	Karura 96 yrs) se 0.87)	Embu (5 yrs) se. 0.87	Hombe (5 yrs) se 0.83	Timboroa (5 yrs) Se 1.56	Marigat (2yrs) Se 0.74
EC	7.34a	3.34a	7.31a	9.36b		11.99b	10.61b	6.75b	4.45a
ET	5.32a	4.20a	10.04a	11.99b	8.71c	11.58b	10.46b	7.21b	4.02a
EG				22.56a	17.26a	14.75b	16.32a	10.17a	
ES				19.28a	14.53b	13.57b	14.56a	10.80a	
EU	7.04a	4.36a	8.07a						
GC 3								11.69a	
GC 14	7.93a	5.45a	6.73a	21.26a	18.53a	17.15a	13.42a	10.88a	
GC 15				22.46a	16.89a	17.04a	14.84a	11.07a	
GC 10				21.24a	18.78a		14.69a		
GC 12					17.70a				
GC17					20.30a				
GC167	8.28a	5.10a	8.69a						
GC584	9.34a	4.44a	7.73a						
GC514	11.64a	5.08a	6.96a						4.88a
GC522				20.75a	18.51a		15.20a		
GC540	9.23a	4.83a	7.19a						5.83a
GC796	7.97a		7.56a						
GC581	8.98a	5.19a	7.59a	19.58a	18.49a	16.39a	16.02a	12.02a	
GC784	9.22a	5.01a	7.70a						5.37a
GC785	10.5a	5.04a	6.63a						
GC642				20.17a	16.80a	16.28a	14.95a	10.89a	
GU21	9.37a	4.59a	9.16a						
GU8	8.43a	3.13a	9.71a						
GU7	8.31a	3.32a	9.08a						

a, b, c = order of performance in height

- DBH ANOVA at five years of age showed that there were significant differences between the clones and species ($p < 0.005$). The performance of the clones and species ranking from the highest in DBH were EG, ES, GC581, GC642, GC522, GC15, GC10, GC14, ES and EC. EC had the highest mean DBH of 17.25 cm.

Timboroa

- At five years of age the ANOVA showed significant differences in mean height of the species and clones at $p < 0.05$;
- The ranking from the highest was as follows: GC581, GC3, GC15, GC642, GC14, ES, EG, ET and EC;
- A two years of a there were no significant differences between the DBH among clones and species but , at age five years there were significant differences ($p < 0.05$);and
- There were no significant difference in the branching habits and stem form between clones and species at age five years.

Gede

- At age two years, ANOVA showed no significant difference in heights among species and clones; and
- However, GC796 were either dead or dying

Sokoke

- ANOVA of height at age 2 years showed no significant differences among and between clones and landraces;
- Performance was the same for all clones and species but GU7 and GU8 were showing signs of water stress.

Msambweni

- ANOVA in the second year showed no significant differences in performance among clones and species; and
- There was an equal performance in all the clones and species grown at this site although GC796 died.

Table 2b. Mean DBH of Eucalyptus clones and hybrids

Spp/ clone	Embu, 5yrs se 1.06	Karura 6yrs se 0.74	Hombe 5yrs s.e. 1.05	Machakos 5yrs s.e. 1.55	Timboroa 5yrs se 1.20
EC	8.93c		11.70b	5.87b	7.07b
ET	8.45c	6.15c	9.65b	9.35b	9.72b
EG	11.86b	14.02a	18.19a	17.25a	11.83b
ES	10.90b	10.72b	14.83a	16.90a	14.84a
GC 3					13.12a
GC 14	14.87a	12.99a	14.60a	13.66a	12.91a
GC 15	15.65a	11.83a	14.41a	14.07a	12.68b
GC 10		13.18a	16.27a	13.94a	
GC 12		12.76a			
GC17		15.65a			
GC522		13.92a	15.51a	14.84a	
GC540					
GC796					
GC581	15.63a	13.64a	16.20a	14.98a	13.99a
GC784					
GC785					
GC642	14.76a	12.54a	16.64a	14.92a	12.81b
GU21					
GU8					
GU7					

a, b, c = order of performance in dbh

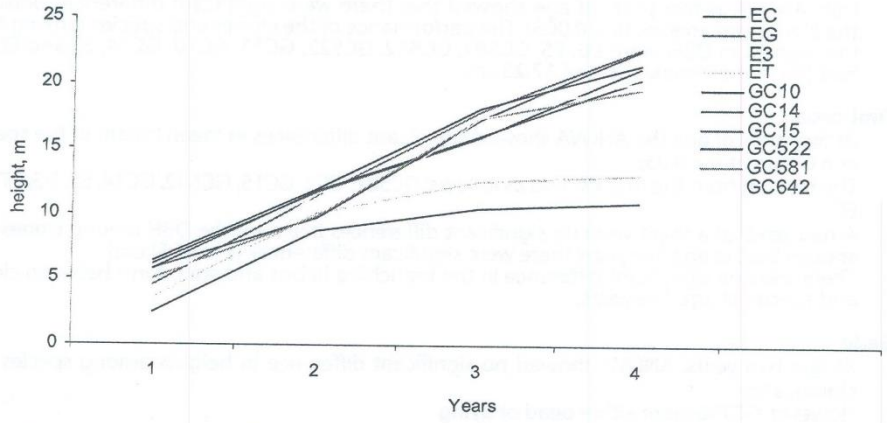

Figure 1. Growth of some Eucalyptus species and clones at Machakos.

Conclusion and recommendations

- Performance of clones and local landraces was not consistent over all sites;
- Assessment suggests that on sites above 2000m, the pure species of EG and ES grow better than clones; and
- Clone GC581 is the best as it excels at all sites (Table 3).

Table 3. Recommended Eucalyptus clones and hybrids for various sites in Kenya

Site	Clones and hybrids
Sokoke	GC 514, GC 785
Msambweni	All clones and species grown at this site except GC796
Gede	All clones and species grown at this site except GC796
Machakos	EG, ES, GC 14, GC 15, GC 10, GC 522, GC 581, GC 642
Karura	GC 15, GC 10, GC 522, GC 581
Embu	GC 15, GC 14, GC 581, GC 642
Hombe	EG, GC 522, GC 581
Timboroa	ES, GC 3, GC 14, GC 15, GC 581 and GC 642.
Marigat	GC 514, GC 540 and GC 784

Pests of Eucalypts in Kenya

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Introduction

The origin of Eucalyptus species is in Australia. Eucalyptus is the tree genus most widely grown as exotic plantations worldwide. Eucalyptus grown in plantations are fast growing, easily cultivated and suitable for industrial plantations or social forestry. The uses of eucalypts range from commercial timber and pulp to soil stabilization, medicinal, fodder, ornamental, shade, windbreaks, tannin, dyes, oils, firewood, charcoal and honey production. Worldwide deployment of eucalypts across the tropics, subtropics and, increasingly, temperate areas has created a mosaic of exotic plantations by which pathogens and pests can move internationally.

General pests of eucalypts

There are many insect pests associated with eucalyptus species and they are classified as borers, defoliators and sap-suckers. Many species of insects attack Eucalypts in both their natural range and places where they have been introduced. A number of Eucalypts infesting insects are of economic importance and could be moved via transfer of germplasm although the risk is lower compared with virus diseases, phytoplasma, bacteria and fungi. Smaller insects, especially sap-sucking insects pose the greatest risk of being moved to new locations via germplasm. Insects may attack eucalypt seed before it is shed from the capsule (gum nut) or after it falls to the forest floor. Other insects lay their eggs in eucalypt flowers. Rooted cuttings of eucalypts present the greatest hazard of movement of insects.

Categories of *eucalyptus* species insect pests

(a) *Sap-Suckers*

These insects insert their mouth parts into plant tissue for extended periods sucking the plant juice and leading to wilting and diebark of the plant. These include members of the insect orders *Hemiptera* and *Homoptera* (e.g aphids, scales, psyllids, lacebugs).

(i) Blue gum psyllid – *Ctenarytaina eucalypti* (Maskell) *(Homoptera : Psyllidae)*
This insect pest has been accidentally introduced into a number of countries where it has caused extensive damage to eucalypt plantings. It is considered to be the most important forest insect pest in Portugal.

Biology

Eggs are laid in masses near the developing buds of host plants. Adults and nymphs feed by sucking plant juices. All life stages may be found throughout the year. Adults are strong fliers and nymphs may be dispersed by air currents. The insect can be transmitted via rooted cuttings

Host Damage

Distortion, wilting of foliage, mostly at the tips followed by leaf drop; dieback of twigs and branches can occur during heavy infestations. There is reduction of growth in young plants due to foliage loss. Nymphs and adults excrete honeydew which provides a medium for growth of sooty mould. Nymphs exude filaments of a white, waxy secretion or 'lerp' under which they shelter.

Distribution

Native to Australia. Accidentally introduced to New Zealand, Portugal and Spain. Its occurrence in Burundi, Tanzania, Ethiopia and Kenya has also been confirmed.

Management Option

Destroy infested germplasm

(b) Borers
These are insects that make galleries in the wood and debark the bark of a tree. Insects in this category are mainly weevils and beetles. Their presence is indicated by frass at the base of trees.

(i) Apate indistincta Murr (Coleoptera: Bostrychidae)
Bostrychids are known as false powder pest beetles since they bore in dry and seasoned wood completely destroying the sapwood. They are generally polyphagous. Bostrychids are economically important borers in the twigs and branches of trees. They generally attack living, dead, or felled trees, and can cause considerable damage. In genus *Apate* adults usually attack living but probably unhealthy trees; larvae however have only been found in dead wood.

Host damage
Young trees have been found very susceptible to attack. Active boring is indicated by presence of frass at the tree base. The attack starts from the bottom of the stem and spreads towards the crown. Weak crown are prone to break when its windy. The borers are most active during dry season and on dry trees. Resin production from frass injection holes on affected trees is a defence mechanism against further insect attack.

Distribution
The pest has been recorded in Kenya, Tanzania, Zambia (on Eucalyptus sp.) and in Malawi. In Kenya, the pest has been recorded in Districts such as Kajiando, Nyandarua, Laikipia, Nakuru, Kuja river, Kiambu and Isiolo.

Invasion
Apate indistincta was first reported in Kenya in 1950.

Management Option
The borers on living trees have been chemically controlled by soaking pieces of cotton wool in Dimethoate, Ambush, or Diazinon and inserting them into frass injection holes. Borers are also killed manually by inserting sharp pieces of wire into such holes. Affected branches should be cut and burnt in order to destroy the life cycle of the pest and hence control the spread of the pest population. Gum exudation kills the adults.

(ii) *Oemida gahani* Dist (Coleoptera; Cerambycidae), Commonly known as longhorn beetle.
Biology
Eggs are laid in batches. Ovipositor occurs on the pruning scars and game damaged areas. The small larvae move inwards to the inner ("dead") part of the tree where, the galleries run up and down the stem. Incubation period is about 38 days. The highest number of eggs from one female is 131. *Oemida gahani* can complete its life cycle in living trees. The shortest life-cycle since recorded is 14 – 15 months. The life period of *Oemida gahani* is about two years.

Host damage
Oemida gahani is a tree stem borer.

Distribution
Widely distributed in all the highland forest divisions in Kenya: Nairobi, Eldoret, Londiani, Nyeri, Thomsons falls and Kisumu.

Invasion
Oemida gahani was first noticed damaging *Podocarpus gracilior* timber in Kenya in 1937. In 1950's and early sixties *O. gahani* was a serious pest in Kenya.

Management Options
1. Larvae are occasionally killed by viral diseases.
2. Plantation hygiene i.e. cleaning and burning all indigenous logs and stumps.

3. Prevention of game damage, fencing and ditching.
4. Early and frequent pruning of host species.
5. Treating of pruning scars with chemicals.
6. Separation of host plantation from natural forest.
7. Structural timber should be sprayed or dipped with a contact insecticide like BHC or DDT.
8. The resin of living wood is lethal to the larvae.

(iii) Termites
Termitidae are subterranean, mould building and arboreal nesting termites. 80% of all known termite species belong to termitidae family. There are 5 sub-families; the common ones are macrotermitinae with genus *odontotermes* spp. *Macrotermes* spp. a *Microcerotermes spp.*

Biology
Termites are social insects like bees. A community is composed of three castes.
- Reproductive adults (for reproduction)
- Sterile soldiers (for protection)
- Sterile workers (for feeding other castes)

The immature stages resemble adults in structure and have wings. Termites have no pupa stage in their development cycle. They feed on wood cellulose.

Host damage
Damage to roots of seedlings, ring barking transplants, damage to tree trunks and dead branches. Termites also cause damage to structural timber leading to collapse of buildings.

Distribution
Found throughout the tropical and sub-tropical areas of the world, and in some areas extending into temperate regions.

Management options

Biological Methods: Pathogenic fungus are used that cause wood rot which poison termites upon feeding on them.

Chemical Control Methods: This involves use of termiticides. Two types of chemical control methods are
(a) Soil treatment
(b) Structural timber treatment
Recommended termiticides for soil against termites are: Marshal suscon, Regent 3G and Dragnet Ft.

Cultural methods: This is use of ash, and sanitation (Removal of wood material)

4. Host plant resistance
Planting of host species that are resistant to termite attack.

Defoliators
This category of insect feed on the foliage of the plants causing reduction of growth due to foliage loss. Defoliators are mainly moths and butterflies although a few families of beetles are defoliators.

(i) *Gonipterus Scutellatus* Gyll (Coleoptera: Curculionidae)
Eucalyptus Snout Beetle Gonipterus Scutellatus Gyll.
The Eucalyptus Snout-beetle, Gonipterus scutellatus Gyll., an Australian curculionid, was first noticed in November 1916, attacking *Eucalyptus* trees. It was probably introduced into South Africa in shipments of apples from Australia some years prior to this date. By 1924 the beetles had spread throughout the *Eucalyptus* growing areas and were attacking about sixty five species of *Eucalyptus* in varying degrees. The three most susceptible species being *Eucalyptus viminalis, Eucalyptus globulus* and *Eucalyptus maideni*. The weevil is widespread in Kenya Highlands.

Life – History of the Snout Beetle
The adult females of Gonipterus lay their eggs in blackish brown egg capsules, only on the young tender foliage of Eucalyptus species. The egg capsules contain about fifteen eggs. The eggs hatch into slimy, yellow larvae which devour the epidermis of the leaf and when fully grown drop to the ground, burrow into the soil and pupate.

Nature of Damage
The damage to Eucalyptus trees is caused by the feeding of both adults and larvae. The preferred feeding place of the adults is along the edge of the leaf. The greatest damage, however, is caused by the feeding of the larvae, which devour the entire epidermis of the leaf. Continued destruction of the young soft twigs and leading shoot and then later moves to debarking of twigs and branches, prevents all height growth. In the course of a few seasons the tree takes on a stunted stag-horned appearance with clusters of dead shoots along the branches.

Remedial measures
In 1926 an attempt was made to control the pest by artificial means. This took the form of dusting plantations with an arsenical poison from aeroplanes. These dusting experiments gave promising results from a control point of view, but proved to be economically unsound and therefore had to be abandoned.

Biological measures
The only likely avenue of control therefore, involved biological control. This measure entailed a search for parasites in Australia.

In 1945 the Kenya Forest Department introduced an egg parasite, *Anaphes nitens* into Western Kenya from South Africa. The parasite was released in the field and the pest and its biological control agent have established a stable relationship country wide in the field.

***(ii) Gonometa podocarpi* Aur. (Lepidoptera, Lasiocampidae)**, Commonly known as Emperor moth.
History
The genus *Gonometa* occurs in many parts of Africa, but *Gonometa podocarpi* seems to be confined to East Africa. *G. podocarpi* was first described by Aurivillius (1925) from Mt. Elgon, Kenya, where the larvae were defoliating the indigenous conifer *Podocarpus sp.* It has since adapted to feeding on exotic softwoods and was first recorded in *cupressus sp.* in 1950 (E.A.A.F.R.O. records). The pest has caused four outbreaks in Kenya since 1977 around Mt. Elgon area.

Biology
The males are smaller than females and a male can mate with several females before it dies. After mating the female lay eggs which are spherical and approximately 2.5mm. in diameter. Newly laid eggs are white but later turn dark grey, though some eggs remain white until hatched. Female lay eggs a day after emerging from pupae. A single female lay 75 to 365 eggs and eggs laying lasts for about 8 days. Female adult live for 10 to 19days and male adult die after mating. The eggs take 12 to 37 days to hatch to larvae.

The larvae is the destructive stage of the pest and measures up to 90mm long with reddish hairs on thorax and long yellowish hairs elsewhere with black urticating needles. The head capsule is also black and has short, white hairs. Larvae take 3 to 5 months to pupate and pupal period takes about 50 days. The life period of *G. podocarpi* is 6 to 9 months.

Host Damage and Distribution
G. podocarpi is a defoliator of *cupressus spp., Acacia spp., Eucalyptus spp., Pinus spp., and Podocarpus spp.* The pest is widespread in the highlands plantations of Kenya, Uganda and Tanzania.

Management Options

(a) Natural

This species is controlled by local parasites:
Palexorista gilvoides Curr, *Pales rubrica* Villeneuve and *Apenteles maculipennis* Cameon. The flies emerge soon after the cocoon has been made. The larva is also parasitized by the Ichneumonid, *Pimpla mahalensis* Grib.
The virus, Nuclear polyhedrosis which caused diseases to *Gonometa* larvae exerted a strong control of the larval populations.

(b) Chemical

Insecticides such as Sumithion (Fenitrothion). Malathion and Gammalin can be used against larval stages of the pest.

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Taxonomy, biology and management options of Blue gum chalcid, *Leptocybe invasa* (Hymenoptera: Eulophidae) in Kenya

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Introduction

Ninety Eucalyptus species and twenty hybrids are widely grown in Kenya but only five are commonly grown: *Eucalyptus grandis, E. saligna, E. globules, E. camaldulensis* and *E. regnans*. There are an equivalent of about 35 000 ha of eucalyptus stands in private farms and 15 000 ha of commercial plantations owned by Forest Department. The estimated yields of these stands is $1.2m^3\ yr^{-1}$, which is about one third of the estimated annual wood yield by the 80 000 ha of forest plantations. A conservative monetary value of eucalyptus trees in Kenya is one billion shillings. However, this could be an underestimate because available statistics are not based on inventory results.

The major uses of eucalypts are; timber for construction, transmission poles fencing posts, honey production, medicinal purposes (fever treatment), oils as perfume, ornamental, shade, windbreaks, and for soil stabilization. In addition, eucalyptus is a potential source of oils. In terms of economic development and rural poverty alleviation, eucalyptus provides economically viable products to the people of Kenya and is a major source of energy for cooking and warming for most people in the Eucalyptus agroforestry system. Tea and tobacco industries are major users of eucalypts firewood for curing tea and tobacco. Other industries that use eucalyptus are the telecommunication industries and paper industries.

Although Eucalypts species have been attacked by a number of pests, the attack has never been of the level reached by the Blue gum chalcid, *Leptocybe invasa* Fisher & La Salle. There is therefore a need to take appropriate action without any further delay.

Taxonomy

Blue gum chalcid, *Leptocybe invasa* Fisher & La Salle is a newly identified genus and species in the insect order Hymenoptera, and belongs to the family Eulophidae in the super family Chalcidoidea, (Mendel *et al*, 2004). This new gall-forming pest has been placed in the sub-family Tetrastichinae. The insect pest attacks the blue gums (eucalypts) and its common name is derived from the host and super family name thus the Blue gum chalcid (BGC). In other countries like Israel, the insect is termed as gall inducer wasp. The pest is believed to have originated from Australia. It has spread to other regions like the Middle East (Israel, Iran, Jordan, and Turkey), Mediterranean (Italy and Spain) and in North Africa (Morocco and Algeria). Recently the insect has been recorded in the eastern Africa region (Kenya, Uganda, and Ethiopia).

Invasion and Spread of Blue gum chalcid in Kenya

Leptocybe invasa was first recorded in Kenya in November 2002 in the western Kenya region. It was noted mostly attacking Eucalyptus species like *E. camaldulensis, E. grandis, E. saligna etc.* Research work carried out by KEFRI in May 2003, showed that, the pest invaded Kenya from the Eastern region of Uganda. The pest spread from the border districts of Kenya and Uganda into western highlands of Kenya. By May 2004, the pest had spread to Busia, Vihiga, Kisumu, Nyando, Butere-mumias, Bungoma, and Teso districts. Recent surveys on the spread of the pest shows that its in coastal region and some parts of the Rift valley. Because of the capability of the insect to fly, its thelytokous reproduction, mulivotinous development, absence of its enemies and the large tracts of host tree, it is forecasted that it may spread through out the country within a period of two to three years. Thus, another catastrophe is looming in forestry sub-sector in Kenya.

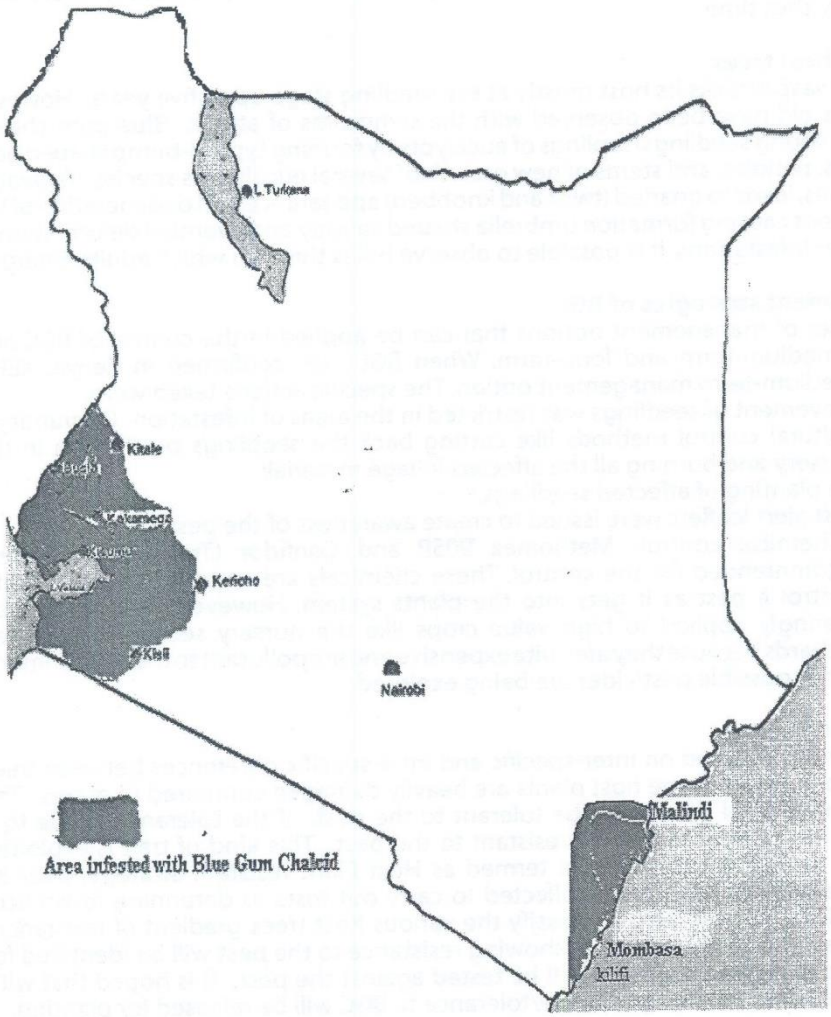

Figure 1. Distribution of Blue gum chalcid in Kenya as at July 2005.

Biology of BGC

Mendel *et al.* (2004) described the biology of BGC. The adult is small and black in colour and has a parthenogenesis (thelytokous) form of reproduction and only females are known. They measure about 1.0 to 1.5 mm long. Larvae are small, legless grubs which are found within the galls on host plants new growth. The larvae pupate within the galls and adults emerge through a hole that they cut at the surface. Adults lay eggs immediately they emerge from the host plants. Eggs are oval in shape, white, and semi-transparent. The eggs are laid in twigs, petiole, leaves midribs, or a few centimetres from the tip of the growing shoot.

The mean development time of BGC from oviposition to emergence at room temperature is 132.6 days (4 – 5 months). The longevity of the adults depends on the type of food taken. In Israel, the wasp produces two or three overlapping generations annually. The number of generations per year in the tropics is not known.

In Kenya, the insect is more active during the dry season. The insect is active and has considerable powers of flight which, when added to the carrying power of winds, can easily infest large areas within a very shot time.

BGC damage on host trees

This gall forming wasp attacks its host mostly at the seedling stage up to five years. However, trees of tens years old have been observed with the symptoms of attack. Blue gum chalcid causes damage to young seedlings/saplings of eucalypts by forming typical-bump shaped galls on the leaf midribs, petioles, and stems of new growth of several eucalyptus species. Repeated attacks on the leaves, leads to gnarled (twist and knobbed) appearance and degeneration of the terminal leader shoot causing formation umbrella shaped canopy and eventual deformation of the plant. On older infestations, it is possible to observe holes through which adults emerge.

Possible management strategies of BGC

There are a number of management options that can be applied in the control of BGC and are classified as medium-term and long-term. When BGC was confirmed in Kenya, KEFRI implemented a medium-term management option. The specific actions taken were:

(a) Movement of seedlings was restricted in the areas of infestation- Quarantine;
(b) Cultural control methods like cutting back the seedlings production in the nursery and burning all the affected foliage material;
(c) No planting of affected seedlings;
(d) Pest alert leaflets were issued to create awareness of the pest;
(e) Chemical control- Methomex 90SP and Confidor (Trade names) were recommended for the control. These chemicals are systemic and can easily control a pest as it gets into the plants system. However, these should be sparingly applied to high value crops like the nursery seedlings and seed orchards because they are quite expensive and are pollutant to the environment. Other possible pesticides are being explored.

Resistance by host plant

This method of control is based on inter-specific and intra-specific differences between trees that are exposed to the pest. Some host plants are heavily damaged compared to others. The trees that are less damaged are said to be tolerant to the pest. If the tolerance is due to a heritable trait, the host tree is said to be resistant to the pest. This kind of trait is exploited as a management tool of the pest and is termed as Host Plant resistant strategy. Over 30 host species/clones/hybrids have been collected to carry out tests to determine resistance/ tolerance against BGC. This will help to classify the various host trees gradient of resistance/ tolerance. Field selection for trees that are showing resistance to the pest will be identified for propagation through tissue culture and will be tested against the pest. It is hoped that with time, clones of eucalyptus that are resistance/tolerance to BGC will be released for planting.

Long-term Options

Long-term management options are chosen from a complex interaction of a number of factors which includes: (I) type of insect pest (exotic or indigenous); (ii) the speed of spread; (iii) the cost to implement the method; (iv) the environmental effects; and (v) chance of success. These considerations are very important in determining what methods to use and where to apply. A good example of a long-term management strategy for a pest like BGC is the Classical Biological Control (CBC) method.

Biological control method for BGC

BGC is an exotic insect pest attacking an exotic tree species. Experiences in the recent past eastern Africa region, has shown that such pests are best-managed through CBC method. This is a form of biological control method that involves importation of a natural enemy from its area of origin/native and introducing it in the area/region/country of invasion. This method is permanent, environmentally friendly and socially acceptable.

However, it has a high initial cost of implementation. Examples of successful CBC programmes in the recent past include: management of cypress aphid, *C. cupressivora, (Syn; C. cupressi)* which threatened to wipe out the widely planted *Cupressus lusitanica* host trees in Cupressaceae in the 1990's. Its management has been achieved through the implementation of CBC through introduction of an exotic biological control agent from France in 2000.

The case of BGC is rather intricate because it has not caused any economic loss on its host trees in Australia where it originated (pers.comm. Mendel, 2003). This is likely due to natural enemies keeping its population below economic injury levels. This fact justifies the need to carry out exploration for the natural enemies from Australia and introducing them to Kenyan and the neighbouring countries.

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The Socio-Economic Impacts Of *Leptocybe invasa* (Hymenoptera: Eulophidae) In Kenya.

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Introduction

The adult of *Leptocybe invasa* (BGC) is a very small (1.0-1.4 mm long) black wasp. The species has been described as a new taxon of Australian origin (Mendel *et al.*, 2004). It lays eggs in the bark of shoots, petioles or the midribs of leaves. The eggs develop into minute, white, legless larvae within the host plant. The developing larvae induce coalescing galls on the host plant meristematic tissue. The galls can cause the twigs to split, destroying the cambium. Small circular holes, indicating exit points of adults from pupae, are common on the galls. Severely attacked trees show gnarled appearance, stunted growth, lodging, dieback and eventually tree death.

In Kenya, BGC was first recorded in November 2002, and preliminary surveys conducted in the country indicate that by May 2004 the pest had spread to several districts including Kisumu, Busia, Teso, Vihiga, Nyando, Butere-mumias and Bungoma (Mutitu, 2003). The pest was observed on *Eucalyptus grandis, E. saligna, and E. camaldulensis*. Surveys in Kenya indicate that *L. invasa* attack is more devastating on seedlings, and that *Eucalyptus camaldulensis* and *E. saligna* were more severely attacked while *E. maculata* and *E. paniculata* seem resistant (G. Hailu, personal communication). In Israel, for example, Mendel *et al.* (2004) observed no *L. invasa* attack on saplings and trees of the hybrid *E. torwood* (*E. torquata* x *E. woodwardii*) and saplings of *E. gomphocephala* and *E. occidentalis*.

There has been increasing concerns on the adverse effects of some chemicals on the environment, and the use of insecticides in controlling BGC may be best suited in nurseries to raise healthy and vigorous seedlings for field planting. Overall, Classical Biological Control (CBC) methods on the gall-forming wasp seem most promising. It was therefore important to carry out survey on farmers' perception, awareness and impact of BGC in order to get a clear picture on its severity and incidence in Kenya. This will help in implementing CBC management method.

Materials and methods

The study was carried out in five Districts in Western Kenya, namely Bungoma, Busia, Nyando, Nandi, and Vihiga. The districts were chosen because the pest attack had been reported earlier in these areas (Mutitu 2004). The ecological conditions in the area favour growth of may species of eucalyptus. (Oballa, 2002).

The study involved collection of primary data through questionnaires administered to 100 randomly selected farmers in the five districts. The questionnaires were administered to farmers with at least one hundred trees of Eucalyptus of less than five years old. Age limit of trees/seedling of five years and below is necessary because canopy of the trees at this age was easily visible allowing sufficient examination on the trees. The age limit was also important because preliminary studies hand shown that BGC prefers young trees. (Mutitu 2004).

Prior to collection of data in the region, reconnaissance visits and pre-tests on the questionnaire were done. The purpose of the study was discussed with forest District Officers and Agricultural Extension Officers in the field who helped in identifying the specific suitable farmers to take part in the questionnaire administration.

Households to be interviewed were randomly selected from each Sub-location. Three enumerators conversant with the study area local language were trained on how to administer the interviews. In each household, the head (Wife /Husband), a representative (mature person) or an employee was interviewed.

Field observations were done by the enumerators to ascertain the interviewee responses. Additional information was gathered through informal discussion with Foresters and Extension Officers incharge the study site. The collected information included method of establishment most preferred in the area and current management problems eucalyptus farmers experienced.

The data collected through questionnaires were entered into SPSS (Statistical Package for Social Sciences) Version 10.0 computer software. Descriptive statistics were used in the analysis to generate both qualitative and quantitative data sets to provide integrated information like the frequencies, mean, sum and percentages.

Results

Demographic and socio-economic characteristics

Ninety one percent of the farmers interviewed were male while 9% were female. Plantation/ woodlot owners who were on farm full-time were 45% and 55% of them being part-time. Majority of the farmers interviewed had at least attained primary (37 %) and secondary education (38 %) 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.

Land tenure

This study has shown that most of the land (62 %) in the region under eucalyptus was inherited. Purchased land occupies 36 %. Some farmers 2 % had their plantation on land that was partially inherited and partially purchased.

Tree population

Most plantations/woodlots (36 %) had trees/seedlings population of over 2000 regardless of the species. 24 % of the farms had a population of between 100-500 while the farms with tree population falling in category of 500-1000 and 1000-2000 were 22 % and 18 % respectively.

Methods of establishment

Most of the eucalyptus farmers (65.7%) preferred Shamba system to establish their plantation while 31.1% of the farmers undertook Grassland planting. Boundary/line hole planting is the least method. (2.0 %) used in establishing eucalyptus.

Table 1. Methods of establishment used by farmers in Western Kenya.

Methods of Establishment	% Response
Grassland planting	31.3
Shamba system	65.7
Boundary/line hole planting	2.0

Reasons for growing Eucalyptus

The study revealed that farmers in Western Kenya grow Eucalyptus mainly for fuelwood, construction and income generation. Farmers also utilise Eucalyptus for timber production, environmental conservation and boundary marking of the farms (Figure 1).

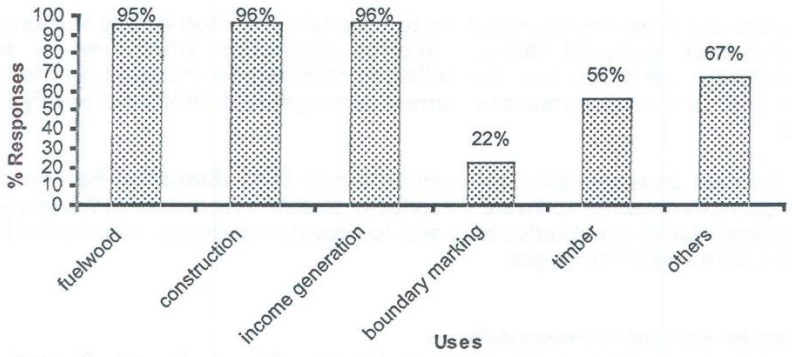

Figure 1. Major uses of Eucalyptus in Western Kenya.

Other uses of Eucalyptus in Western Kenya includes; medicinal purposes, windbreaks, and fencing.

Farmers' awareness and perception of BGC.

Most farmers interviewed (88.2 %) were not aware of BGC. Only a small percentage (11.8 %) knew that there is a pest insect infesting eucalyptus trees in the area. However, most of the farmers knew that an insect caused the infestation but they were not aware of it specifically (Figure 2)

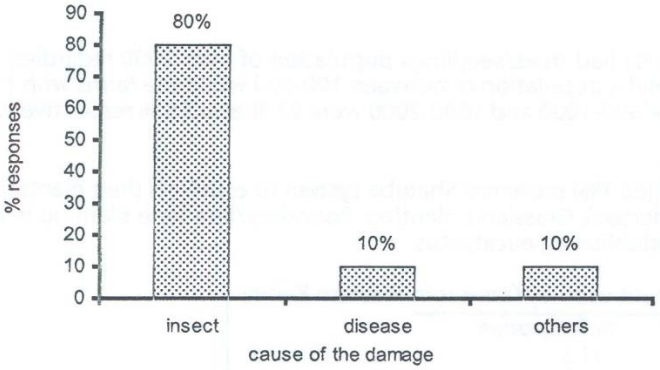

Figure 2. Farmers' perception on cause of damage symptoms on eucalyptus

Levels of damage by the pest on trees

The study revealed that the pest mainly caused deformity and reduced the growth rate of the eucalyptus trees. Other damaging effects of the pest included wilting of the seedlings (figure 3).

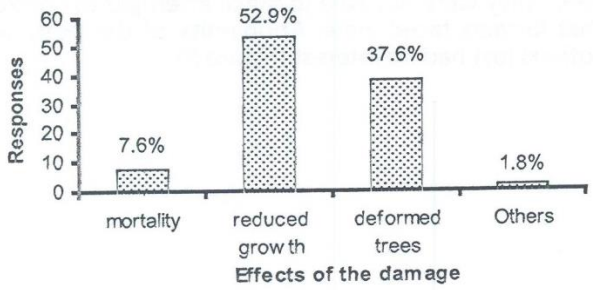

Figure 3. Damaging effects of BGC on host trees

Other causes of eucalyptus mortality in the region.
Other causes of mortality of Eucalyptus trees in the Western Kenya area included drought, termite attack, diseases, fire, animals as the (Table 2)

Table 2. Causes of mortality of Eucalyptus in Western Kenya

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

Damage by BGC at different growth stages of Eucalyptus.
The result of the study showed that the most affected tree/seedlings were those less than one year old. Trees of 1-3 years were moderately attacked. There was low attack on trees of 3-5 years old with trees of over five years old suffering little or no attack (Figure 4)

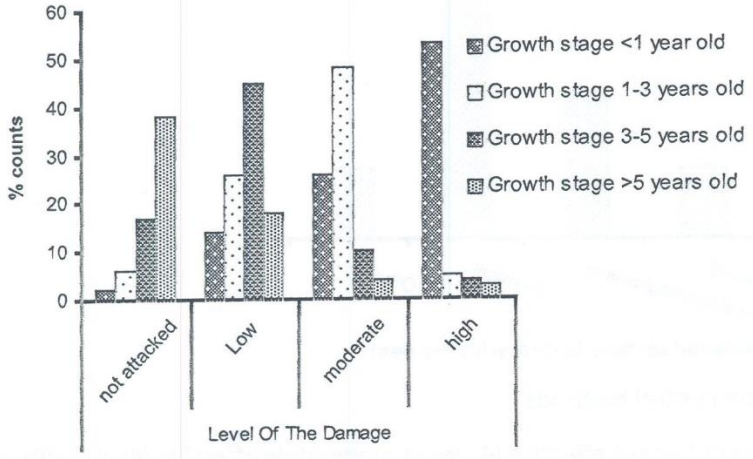

Figure 4. Damage levels on Eucalyptus tree/seedling at different age.
(20 % of trees attacked). Moderate =20-50 % of trees attacked. High =(>50 % of trees attacked)

Many farmers have not been able to control BGC and not made an attempt. Only 28 % of all respondents made an attempt to control the damage. Lack of know how on control methods was the major problem to farmers, hence they were not able to make attempts to control the damage. Among other constraints that farmers faced were; Anonymity of the pest, lack of money to buy control chemicals and others just had no interest (Figure 5).

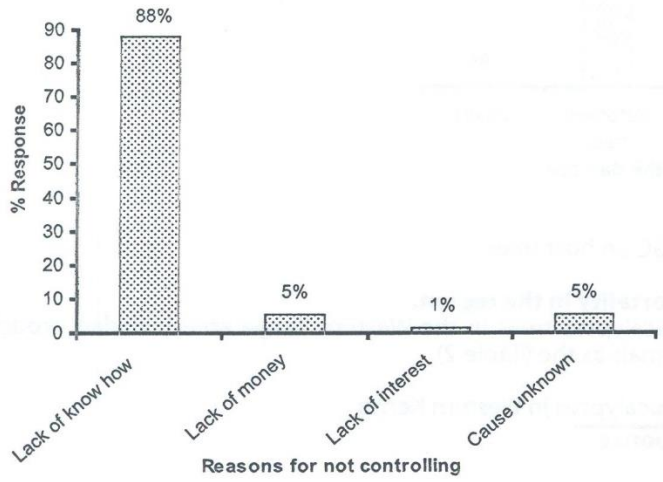

Figure 5. Graph showing farmers' reasons for not controlling the damage.

The few farmers who attempted to control the pest received advice on control methods from Foresters, extension officers, friends and neighbours and KEFRI staff in the area. The advice farmers received on the control methods include; planting of resistant Eucalyptus species, use of cultural methods, physical and mechanical methods and Chemical use. The most recommended control method was planting of resistant species, physical/mechanical method and chemical control method (Figure 6).

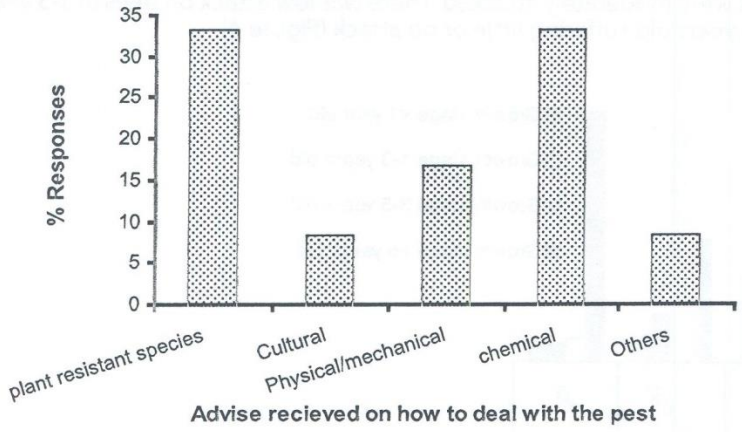

Figure 6. Advice received on control methods

Most control methods were either not effective (41 %) or moderately effective (46 %) with only 14 % being highly effective (Figure 7).

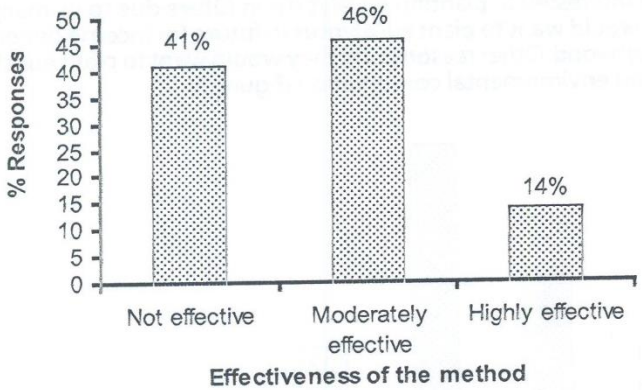

Figure 7. The graph showing effectiveness of the control methods

BGC spread trend

Farmers in the region first noted damage by BGC as early as year 2000 in Vihiga and Busia. Since then, the pest has spread to other three districts namely: Bungoma, Nyando, and Nandi (Table 3).

Table 3. Spread trend of BGC in Western Kenya.

Year BGC first seen	Districts
2000	Vihiga and Busia
2001	Vihiga, Busia and Bungoma.
2002	Vihiga, Busia and Bungoma
2003	Vihiga, Busia, Bungoma and Nyando.
2004	Vihiga, Busia, Bungoma, Nyando and Nandi

Farmers' coping strategies

In view of this damage, 57.9 % of the respondent were still willing to plant eucalyptus, 36.5 %, and would want to seek advice first before planting and % were adamant about the damage and would wish to advice people not to plant Eucalyptus. About 2 % of the respondent did not know how to cope with the damage (Figure 8).

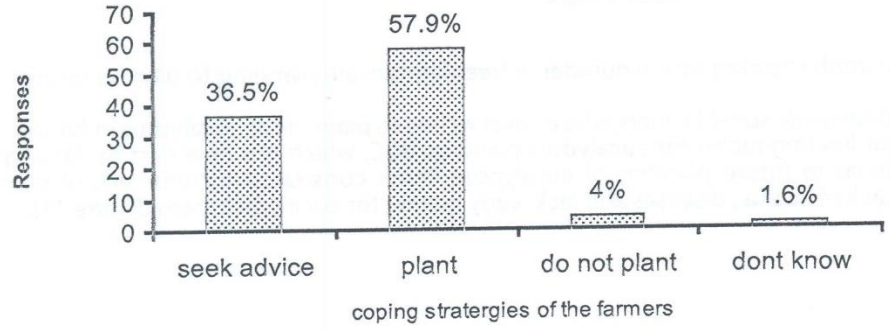

Figure 8. Coping strategies of the farmers

Farmers' future plans

Over 95 % of the farmers were interested in planting eucalyptus in future due to its many uses and fast growth. Many people would want to plant eucalyptus in future for income generation, timber/construction and for fuel wood. Other reasons why they would want to plant eucalyptus are marking farm boundary, and environmental conservation (figure 9).

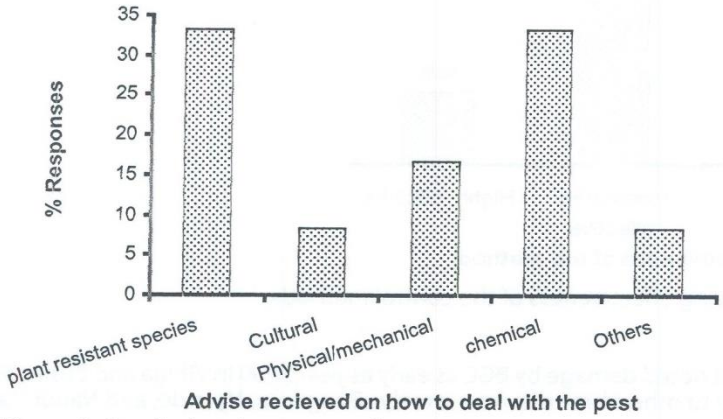

Figure 9. Graph showing reasons for growing more Eucalyptus in future

Future plantations

The request of study showed that, 48 % of the farmers are willing to plant between 50-1000 eucalyptus trees, 42 % between 1500-10 000 trees while 10 % aimed to plant over 10 000 trees (Figure 10).

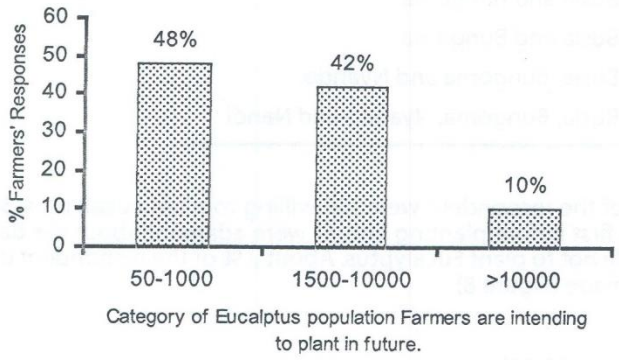

Figure 10. Graph showing future number of trees farmers are planning to plant in future

However there were some farmers who are not willing to plant more eucalyptus in future. Land is the major limiting factor for eucalyptus planting. BGC, which is a new pest for Eucalyptus, poses a threat to future planting of eucalyptus. Other constraints include lack of planting material, Lack of capital, diseases and lack ready market for eucalyptus trees (Figure 11).

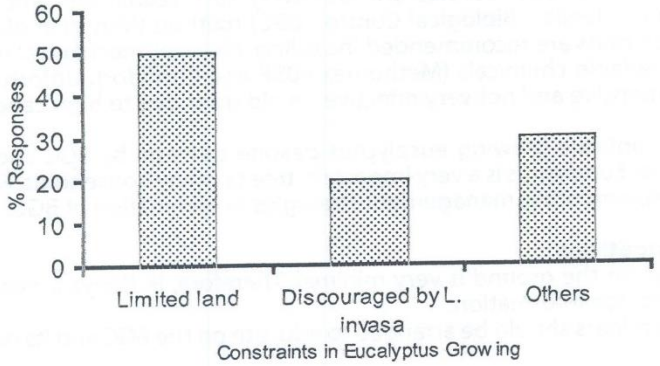

Figure 11. Constraints eucalyptus farmers are facing in an attempt to expand Eucalyptus plantations

Discussion

Most farmers cultivated over 500 Eucalyptus trees on their farms indicating that there is high demand for its products.

Result of studies done on Comparative evaluation of Farm forestry enterprise Versus Maize cultivation in Western Kenya, Profit were higher from eucalyptus coppices than Maize. This makes commercial planting of trees on farm more appealing (Cheboiywo, 2004) and its in line with the results of this study that have shown, that the major reasons people are planting eucalyptus is for income generation as well as other important uses. Indeed eucalyptus trees are major source of fuel wood, income generation and in construction in Western Kenya as was also observed by Oballa (2002).

Shamba system is the most preferred method of establishing eucalyptus in Western Kenya. This could be due to the fact that, agriculture is the major source of livelihood and most households are small-scale farmers. The small farm size means that there is greater pressure on farmland thus shamba system provides additional land space for growing Eucalyptus.

The farmers interviewed were not aware of pest but they had noticed the damage on eucalyptus. Eucalyptus is the major source of tree products and this explains the farmers' interest in the damage on tree in 2000, three years before it was reported to KEFRI (Mutitu, 2003).

Eucalyptus trees under five years were reported to be more susceptible to BGC attack. The pest lays its eggs in tender twigs. Young plants/seedlings of Eucalyptus have tender parts making them favourable for insertion of eggs by adult wasp (Mendel *et al.,* 2004). Young plants also have more meristemtic growth tissue, which is favourable for development of BGC.

Drought, termite and diseases are other major causes of mortality in Eucalyptus in Western Kenya. Drought increases water loss through evapotranspiration causing wilting and subsequently death of trees. Termites attack mainly young exotic trees (Harries, 1971). Since the time eucalyptus was introduced to Kenya, they have suffered few cases of diseases (Oballa, 2002).

BGC is spreading very fast in the region, and within four years it has spread to five districts namely Vihiga, Busia, Bungoma, Nyando and Nandi. This spread is attributed to the ability of the pest to fly from one host tree to another (Mutitu, 2003).

Most farmers were not able to control the pest due to lack of know-how on control methods because BGC is a new pest. However, studies are underway to research and implement long-term solution in form of Classical Biological Control (CBC) method (Mutitu *et al.,* 2004). Nevertheless, short term solutions are recommended including; Physical/mechanical method and use of commercially available chemicals (Methomex 90SP and Confidor). Unfortunately, these chemicals are very expensive and not very effective on old trees due to high canopies.

Farmers are still willing to continue growing eucalyptus despite damage by BGC and other constraints. This indicates that Eucalyptus is a very important tree to many households. Farmers are also willing to help in implementing management strategies in elimination of BGC.

Conclusion and recommendations

- Information on the BGC on the ground is very minimal. Therefore, in Kenya a need for a pest alerts leaflets to provide information.
- More workshops and seminars should be arranged to educate on the BGC and its possible management options.
- More research should be done to provide long-term solution to BGC. Hence, government and other funding institutions should therefore encourage researchers by funding a study to develop a method to control BGC.

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Phytosanitary Measures as a Management Tool for Exotic Pests in Kenya

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[2] Kenya Forestry Research Institute,

Introduction

Exotic, invasive pests are not new phenomena in many countries in the world and the movement has always followed paths of human travel and commerce. However of recent, the world is experiencing a wave of exotic species introductions never experienced before. This is attributed to the rapidly expanding global economy, relaxed trade barriers, efficient and rapid means of transport, widespread movement of large volumes of all kinds of plant materials and restricted use of pest control chemicals.

Globally, the International Plant Protection Convention (IPPC) and World Trade Organization (WTO) agreement on the application of sanitary and Phytosanitary (SPS) measures provide the guidelines of plant import and export regulations to prevent the spread of exotic pests. Kenya is a signatory to both IPPC and WTO-SPS agreements and all our trading partners are either contracting parties to IPPC or have adopted the International Standards for Phytosanitary Measures (ISPM) as set by the Interim Commission for Phytosanitary Measures (ICPM) under the auspices of Food and Agricultural Organization (FAO) of the United Nations.

Phytosanitary measures include any legislation, regulation or official procedure having the purpose to prevent introduction and/or spread of pests. These must be scientifically justified, least restrictive and provide minimal impediment to international trade.
Whereas mechanisms to prevent the spread of exotic pests have worked well over the years, exceptional cases arise and exotic species spread across international boundaries.

Phytosanitary Services in Kenya

Kenya has very stringent plant introduction and certification procedures since 1930's when the plant quarantine services were started in East Africa. These procedures ensure that foreign injurious pests, diseases and noxious weeds which do not exist in Kenya are not introduced in the country. KEPHIS is mandated by law to offer phytosanitary services in Kenya and all phytosanitary measures are based on international standards such as IPPC and WTO-SPS regulations and guidelines. The Plant Protection Act (CAP 324), the suppression of Noxious weeds (Cap 325) and the Agricultural produce (Export) Act (Cap 319) provide the legal framework through which the authority carries out phytosanitary services.

Plant import regulations

Plant import regulations in Kenya fall into three broad categories;
Imports under which a plant imports permit only is required
In this group, importation of a particular plant is permitted because the plant material is known to carry minimal risk. However, imports are permitted from certain clearly defined areas of the world only and importation of the same species from other areas may be prohibited. This is because either an important disease does not occur in certain areas, or the plant protection authorities of that country can be relied upon to certify plant material as free from pest/disease. The conditions for import are indicated on the import permit.

Imports that must be quarantined

In this group, importation carries a risk of introducing dangerous organisms. For the majority of plants and seeds that require to be quarantined, diseases associated with the plants are extremely difficult to detect and the plant material carrying them may appear vigorous and healthy.

Imports that are prohibited

Importation of plant materials classified as prohibited carries very high risks and as such must not be imported under any circumstances. Examples are timber with bark, Christmas trees, paddy rice, and vegetative materials of certain legumes such as cowpea, soybeans, Lucerne and lentils.

Procedures for importation of plant materials

Importation of any form of plant material into Kenya is subjected to strict specified conditions outlined below:

- All plant importers intending to bring plant material into Kenya should obtain a Plant Import Permit (PIP) from KEPHIS. The PIP is issued after careful appraisal of the risk involved in importing the intended plants or plant products. The permit specifies the requirements for plant health, indicating prohibitions, packaging, conditions for release at the point of entry, and other additional declaration with regard to pre-shipment treatments. The original permit must reach the plant health authorities in the country of origin for strict adherence to Kenya's import requirements
- Any plant consignment arriving into Kenya must be accompanied by the original PIP and a Phytosanitary Certificate which verifies that a competent authority in the exporting country examined the plant material for pests and diseases prior to their leaving the country and that the plant materials meet Kenya's phytosanitary requirements.
- Plant material arriving in Kenya without authority and correct accompanying documents is not allowed entry and may be destroyed or reshipped at owner's cost.
- All imported plant material must be declared to a Plant Inspector at any point of entry. Plant inspectors have been stationed at all major entry points into Kenya.
- Any person who contravenes or fails to comply with the regulations shall be guilty of an offence and shall be liable to a fine or imprisonment or both.

Inspection at entry/exit points

KEPHIS undertakes inspection of the plants and plant products at the points of entry/exit to ensure compliance to the recommended phytosanitary and quality standards. Inspection may be visual, microscopic or a combination of both on plants/plant products at airports, seaports, mail and border posts. Usually samples are inspected according to the type and volume of the commodity. Inspection levels are determined by the assessed risk of the commodity. Plant materials failing to meet the standards are destroyed or prohibited from leaving or entering the country.

Plant quarantine services

Plant quarantine services play an important plant protection role during the transfer of plant genetic material. Latent infections of seeds and other plant preparative organs with viruses, fungi, bacteria or nematode may occur even after treatment and thus at the plant quarantine station, imported high risk plant materials are grown under observation for certain period of time before they are released to the importer. Additionally, viruses infected breeders' seed or high value plant materials are cleaned through thermotherapy and chemotherapy. Meristem tips of the treated plants are then cultured to produce disease free material. This reduces the chances of introduction of harmful pathogens.

Despite quarantine measures having been put in place, pest can spread across border or within countries. This has happened with the blue gum chalcid, which has spread from Uganda to Kenya. Within the country the pest has spread naturally or through movement of plant material. Tranboundary and local movement of pests is thus difficult to control.

Biological Control Organisms

The Kenya Standing Technical Committee approves importation of biological control agents of any nature for Imports and Exports (KSTCIE) chaired by the Director of Agriculture. KEPHIS inspects the containment premises of biological control organisms and ensures strict adherence to import conditions as specified by KSTCIE.

Genetically Modified Organisms (GMOs)
Applications for importation of genetically modified organisms (GMOs) are considered by National Biosafety Committee (NBC), which draws experts from National Council of Science and Technology, Ministry of Agriculture, KEPHIS, local universities, local and international research institutes and environmental pressure groups. KEPHIS enforces the regulations and guidelines for safety in biotechnology as stipulated by the NBC.

Pest eradication programmes
Despite having phytosanitary measures in place, pests may sometimes be established and a programme for pest eradication should be developed as an emergency measure to prevent establishment and/or spread of a pest following its recent entry (re-establish a pest free area), or as a measure to eliminate an established pest (establish a pest free area)

A cost benefit analysis of a pest eradication programme should be undertaken after consideration of data collected at the site(s) of pest detection or occurrence, the extent of infestation, information on the biology and potential economic impact of the pest, current technology and available resources for eradication. It is also useful to gather information concerning the geographical origin of the pest, and pathways for its re-introduction.

The pest eradication process involves three main activities: surveillance, containment, and treatment and/or control measures. When an eradication programme is completed, the absence of the pest must be verified and a declaration made that the pest has been eradicated.

ISPM No. 15: Guidelines for controlling wood packaging material in international trade
The IPPC has recently developed guidelines (ISPM No. 15) that describe phytosanitary measures to reduce the risk of introduction and/or spread of quarantine pests associated with wood packaging material used in international trade. The guidelines cover wood packaging material such as pallets, dunnage, crating, packing blocks, drums, cases, load boards, pallet collars, and skids which can be present in almost any imported consignment, including consignments which would not normally be the target of phytosanitary inspection.

Wood packaging material is frequently made of raw wood that may not have undergone sufficient processing or treatment to remove or kill pests and therefore becomes a pathway for the introduction and spread of pests. Furthermore, wood packaging material is very often re-used, recycled or re-manufactured and thus the true origin of any piece of wood packaging material is difficult to determine and its phytosanitary status cannot be ascertained. For this reason, this standard describes globally accepted measures that are approved and that may be applied to wood packaging material by all countries to practically eliminate the risk for most quarantine pests and significantly reduce the risk from a number of other pests that may be associated with that material. Kenya had adopted these guidelines to reduce the risk of introduction and spread of exotic pests associated with solid wood packaging material

Collaborations with government institutions and the international community
KEPHIS collaborates with institutions such as KARI, KEFRI, NEMA, ICIPE, CABI and FAO in carrying out activities of phytosanitary importance such as pest surveillance, pest risk analysis, and in acquisition of relevant plant protection information through research. Additionally, there is strong collaboration with government agencies such as Customs and the Postal Corporation to prevent introduction of exotic pests.

Conclusion
The increase in movement of plants and plant products poses a risk of moving unwanted organisms into new environments. Our challenge therefore is to prevent the movement of pests without affecting free trade. This will require the cooperation of governments, agencies, industry, research institutions, and private citizens around the world.

The BGC Afornet Project: Distribution and Impact of BGC on Eucalytpus Species in Kenya

K.E. Mutitu,
Kenya Forestry Research Institute

Project Justification

- Eucalyptus has been widely grown in East Africa for about a century now for its many uses.
- It is estimated that in Kenya Eucalyptus cover over 50,000ha of land (Forest Department about 15,000 ha and private sector about 35,000 ha).
- Over 70% of the rural population in Kenya and Uganda derive their fuelwood from Eucalyptus.
- Recently a new threatening gall, BGC, *Leptocybe invasa* has been observed to damage the Eucalyptus in Kenya and Uganda.
- This study therefore will help to determine its economic importance and sustainable management strategies.

Project Goal

- To contribute to productivity of Eucalyptus species in East Africa through provision of Information necessary for sustainable management of BGC through;
  - Documenting farmers experiences on BGC attack and their coping strategies
  - Determining and mapping the current distribution of BGC in Kenya and Uganda.
  - Quantifying the severity incidence and damage of BGC.
  - Determining the variability in BGC attack between Eucalyptus species and clones.
  - Explore possible management option.

Project Activities

- Stakeholders Sensitisation's workshop. The workshop will be organised to create awareness on the pest problem and the project. The workshop will be organised for
  - Farmers and foresters in the region of infestation.
  - Technical staff and research stakeholders from forest ministries, Research institutes, private entrepreneurs, tobacco farmers and plantation managers

- Farmers' indigenous knowledge, perception and control practices.
  - Socio-cultural and economic surveys in at least five districts will be conducted using pre-test questionnaires.
  - Special emphasis will be on farmers' awareness, control practises, and constraints of BGC.
  - The future plans on Eucalyptus will also be captured.

- Quantitative assessment and mapping of Distribution and severity of BGC. This will help identify areas of priority for implementation of management strategies.
  - This will be done simultaneously with farmer survey.
  - Three plots of 20 trees/seedlings will be randomly established. Every tree will be scored for incidence and severity ob BGC.
  - Gall incidence will be expressed as proportion of total seedlings/trees sampled
  - Severity of galls will be scored on the four scales (None, Minor, Moderate and severe)
  - The distribution will be done in terms of longitude, latitude, altitude etc of different locations visited.
- Monitoring the wasp population and gall damage dynamics. This will assist in management strategy implementation.
  - Five woodlots of *Eucalyptus grandis* will be selected in the five districts.
  - Total of 100 trees will be randomly selected from each woodlot and will be monitored for 2 years at two months interval dates.
  - Number of galls and emergence holes will be counted per 10 cm shoot length.
  - Beating traps will be used to trap and count wasps' population.

- Diversity of natural enemies will also be determined using the beating trap.

- Evaluation of Eucalyptus and clones. This will be used to establish host plant resistance strategy.
  - At least 100 seedlings of each Eucalyptus species/clones will be evaluated.
  - Green house experiment will be completely randomised
  - Field experiments will be done in two districts in complete randomised block design
  - Survival and growth, incidence and severity of galls, diversity of natural enemies of wasp and incidence of other pests and diseases will be evaluated.

- Biological control intervention
  - This is a permanent solution to the problem.
  - This will be achieved through proposed international proposal between Kenya (KEFRI) and Israel.

Project Expected Output

- Areas of infestation in Kenya will be mapped out. This will to be used later when implementing management strategies.
- Document farmers' opportunities and limitation in managing BGC.
- Quantify Eucalyptus damage levels and loss by BGC.
- Develop standard damage assessment protocol of BGC population.
- Identify BGC natural host range and resistant species/clones.
- Explore possibilities of using Biological control as long-term management option.

Achievements of BGC AFORNET project as at March 2006.

- Identified and documented Farmers' opportunities and limitation in managing BGC in Western Kenya
- Carried out Farmers/ Foresters workshop in Western Kenya.
- Quantified Eucalyptus damage levels, and incidence and severity of BGC in Western Kenya.
- Collected GPS points in areas of infestation in Western Kenya, which will be used to map out areas of infestation in the region.
- Has set up host resistance range trial plots in Western Kenya that will be used to identify BGC natural host range and resistant species/clones.

GROUP DISCUSSION TOPICS

Group Discussion – One
Topic: Management of BGC
Scope of discussions;

- What management options have been applied in your area?
- What was the source of advice on the management option applied in your area?
- What is the effectiveness of the control method?

Group Discussion – Two
Topic: Impacts of BGC
Scope of discussions;

- Losses due to BGC infestation
- Effects on planting of Eucalyptus in the region
- Species highly susceptible to BGC
- Age highly susceptible to BGC.
- Areas/distribution of BGC
- Areas not infested with BGC

Group Discussion - Three
Topic: Future plans on how to control the Eucalyptus damage.
Scope of discussions;

- What should be done in future to control BGC?
- What advice can you give to Eucalyptus growers in view of BGC damage?
- What is the fate of Eucalyptus in future? Should farmers plant more or not to plant?
- What is the best way do you think information on BGC can be disseminated?

Group Discussion Presentations Summaries

Group 1: Management options for BGC

(A) Management Option applied in the area

- Use of chemicals (methomex 90SP, Confidor and Furadan)
  Effectiveness: Only effective at initial stages of growth but expensive to buy;
- Heavy water regime
  Effectiveness: Reduces the effects of the BGC
- Identifying and isolating infected seedlings/trees
- Cultural methods- Concoction of pepper and soap
  Effectiveness: Reduces the effect of BGC
- Transplanting during rainy season.
  Effectiveness: Low
- Use of guard rows in planting to reduce external infection
  Effectiveness: Lowers the rate of infection
- Planting unaffected seedlings only.
  Effectiveness: Reduce pest contact

Group 2: Impacts or BGC

(A) Impacts of BGC infestation

1. **Losses**
   - Low timber production is anticipated in future due to BGC damage.
   - Low fuel wood availability due to retardation of growth of Eucalypts
   - Low-income generation to farmers who relay on Eucalyptus as source of charcoal and construction materials for sale, etc.

- Reduced government revenues from companies who rely on Eucalyptus, as row materials for their production like Pan paper, British American Tobacco Limited, and Tea Companies.
- High expenditure in purchasing Chemicals to control the BGC damage.
- High expenditure to carry out research by funding bodies on possible control methods.
- A lot of time is spending by the researchers in researching on the solution to the pest.
- Micro-climatic effects due to reduced population of Eucalyptus trees, which adds up the forest cover of the region. This affects the rainfall patterns.

2. **Effects on Planting Eucalyptus**
   - Reduced production of Eucalyptus seedlings in tree nurseries.
   - Reduced planting of Eucalyptus in the field due to low esteem towards Eucalyptus growing.

3. **Species highly Susceptible**
   - *Eucalyptus saligna, E.camaldulensis and E. grandis*

4. **Age highly affected**
   0-1 years old tree/seedlings

Group 3: Future plans on how to control the Eucalyptus damage

What should be done to control BGC in future?

1. **Immediate term control options**
   - Awareness to the public in both affected and unaffected areas.
   - KEFRI with other collaborators to enforce quarantine measures on Eucalyptus affected areas.
   - Integrated seminars, workshops and *barazas* should be organised, by Ministry of Agriculture, Ministry of Water, NEMA, KEFRI, KEPHIS, etc to sensitise farmers on the pest and possible control methods.
   - Document traditional management methods farmers are using to control BGC in their farms.

2. **Long term measures**
   - Promote use of BGC resistant clones/species of Eucalyptus.
   - Research on the natural enemies of BGC that will be used as biocontrol agents.

Advice Farmers can give in view of this damage

1. Based on the past experiences, for instance Cypress damage by Aphids, which its long-term management solution was found, there is high possibility of finding a solution to BGC.
2. Farmers should be very observant i.e. making regular inspection to their trees/ seedlings and report any abnormal growth of the plant immediately to KEFRI through Forest Department.

Fate of Eucalyptus in future in view of BGC damages

From past experiences farmers were confident that KEFRI efforts would find long-term management solution to BGC.

The best way on how to disseminate information about BGC.

1. BGC campaign and awareness should be incorporated in Public administration *Barazas* and other forums e.g. Church, Weddings, funerals and Farmers' campaign action groups.

2. Use of posters in social amenities and other public places in a more understandable language and easy-to-read pictures.

3. Use of print and electronic media in popular TV and Radio stations in different regions.
4. Use of government ministries, Non Governmental Organizations (NGO's) to disseminate information on BGC.

Workshop Resolutions

The following resolutions were adopted during the plenary session.

1. Enhance BGC awareness campaign through public forums, workshops and through print and electronic media;
2. Establish Tree Biotechnology Plots in Busia and Bungoma to provide Eucalyptus clonal materials for farmers in Western Kenya;
3. KEFRI will co-operate with other stakeholders like NEMA, KEPHIS, and Forest Department to fight against BGC;
4. The workshop stakeholders be good ambassadors to encourage farmers to plant Eucalyptus despite BGC invasion; and
5. The stakeholders to be good ambassadors in encouraging farm forestry as an alternative cash crop.

Closing remarks

Linus Mwangi
Principal Research officer
Kenya Forestry Research Institute

Ladies and gentlemen, today marks the end of the workshop, which started on Tuesday. During the workshop you had presentations and discussions on Clonal Eucalyptus and the blue gum chalcid pest affecting Eucalyptus particularly in Western Kenya. Unfortunately the pest is spreading to other areas. Being a new pest a lot of research and information is required. You have also heard about the impact of the problem and measures that could be used to control the problem. Indeed, I am encouraged that some farmers have attempted to control the pest. It is this information that is useful to you and to others whose services you provide in the field.

I was encouraged by the interest you have shown in this problem during discussions. The resolutions you have made will go along way in shaping the direction, which should be taken to KEFRI on trying to solve the pest problem. The research being undertaken by KEFRI will help in finding a long-term solution to the problem. In particular, the work being undertaken by the AFORNET project addresses major issues on the pest. In this connection, KEFRI has also made efforts to disseminate information on the pest to stakeholders.

I would like to thank AFORNET for providing the financial assistance. The organizers of the workshop, the session chairmen, Presenters, the Mabanga Farmers Training Centre Staff, and last but not the least the participants without whom the workshop would not have been a success. I wish you a safe journey back.
With these few remarks I declare the workshop officially closed.

Thank you and have a pleasant journey back home.

Appendix I: List of Workshop participants

1. Bungoma District

Foresters

1. Francisca Wanzala, Chwele, Box 506, 0735 161043 - Bungoma (Qn)
2. Evelyn Nekoye, Forester Tree Nursery, Mabaga FTC* – Bungoma (Q 92)

Farmers

3. Maurice Nagulu, Sirisia Division, Sirisia Location Bungoma. (Q90)
4. Godfrey Muse, Malakisi Division, Malakisi Location. Bungoma. (Q70).
5. Patrick Sienda, Chwele Division, Mukuyuni Location (Q65).
6. Cleophas Musiku, Kanduyi Division, Kibabii Location. (Q85).

2. Busia District

Foresters

7. Urbanus M. Katiwa, Box 23, 0723 767361, Funyula Forester.

Farmers

8. Martin L. Otuga Asewe, Box 307, Nambale,(Qn 45)
9. Pastor Stephen Omondi, Box 8, Butula, 0723 798985 (Qn 51)
10. Mathias Ogoma, Matayos Division, Nambaboto location Busia (Qn50)
11. Martin Lutha Otuga Osewe, Nambale Location, Nambale township (Qn 45)

3. Vihiga District

Foresters

12. Joel Mahiva, Box 781, Maragoli, Forester Vihiga, 0722 167934 – Vihiga

Farmers

13. Gerishon Mulahya Matini, Vihiga Division, South Maragoli. (Q2)
14. Shadrack Horace Vumbe, Luanda Division, south Bunyore. (Q9)
15. Kenneth Madeda Kafuna , Sabatia Division, Izava Location. (Q19)
16. Fredrick Odindo, Luanda division, West Bunyore Location (Q27)

4. Nyando District

Forester

17. Kisumu Forester.

Farmers

18. Mrs Christabel Ouko, Muhoroni Division Koru Location (Q98).
19. Bosco Odhiambo, Muhoroni Division, Koru Location. (Q96)

5. Private Company Foresters

20. Pan-Paper Mill (PPM) – Mr. Aggrey Makari kitui
21. Homalime – Private sector – Mr. E. Okeyo Ouko
22. Sotik Tea Company- Mr. Julius Kamau
23. Mastermind Tobacco Company- Franciss Kinje Mbwaba

Appendix II: Workshop Programme

Time	Activity	Resource Person
21 March 2006: 4.00 pm	Arrival of participants at the Training Centre	Organisers
21 March 2006: 8.00 am	Participants Registration	Organisers
8.30 am	**Session 1: Official opening and introduction** *Chairman: Mr. Linus Mwangi* Introduction of participants and workshop programme and procedures Welcoming remarks Official opening	 Mutitu K.E. DFO, Bungoma Dr. Mbae Muchiri, Asst. Director, Forest Plantation programme
9.30 am	Status of Eucalyptus growing in Kenya	Dr. P. Oballa Lydia Wamalwa- KEFRI
10.00 am	Clonal Forestry in Kenya: The Eucalyptus case.	Dr Mbae Muchiri
10.30 am	**TEA BREAK**	
11.00 am	Discussions	
11.30	Pest of Eucalyptus in Kenya	Njenga F.
12.00	Biology and Taxonomy of Blue gum chalcid	Mutitu K.E.
12.30 pm	Discussion	
1.00 pm	**LUNCH BREAK**	
2.00 pm	**Session II: BGC Impacts** Chairman: Mr. K.E. Mutitu	
2.00 pm	Social-economic Impacts of BGC in Western Kenya	K.E. Mutitu, Otieno B. & Kemboi G.
2.30 pm	Phytosanitary measures as a management tool for exotic pest in Kenya.	Mwangi L.
3.00 pm	Discussions	
4.00 pm	**TEA BREAK**	
4.pm	Titles for group discussions and Guidelines	Resource person
22 March 2006: 8.20 am	Discussion Group Formation Group Discussion	
10.30 am	**TEA BREAK**	
11.00 am	Plenary Group Presentations and Discussions.	
11.45 am	AFORNET PROJECT: Goals, Objectives	Mutitu K.E.
12.15 pm	Workshop Resolutions.	
12.45 pm	Vote of thanks and official closing	
1.00 pm	**LUNCH BREAK AND DEPARTURE.**	