Book of Abstracts and Timetable

We are grateful for the below sponsors supporting the 1st ICPP in a multitude of ways.

The 1st ICPP is the brainchild of the ADAPPT project, supported by a European Union project that focusses on building scientific capacity in Africa. See www.nri.org/adappt for more information

NRI is the lead partner of ADAPPT and leader of the ICPP's international scientific committee. NRI has been at the forefront of research on pesticidal plants in Africa for more than 50 years.

The International Centre for Insect Physiology and Ecology is our host for the ICPP. *Icipe*-African Insect Science for food and health is the editorial home of the *International Journal of Tropical Insect Science*.

Egerton University is a partner and WP 4 leader of ADAPPT Network, leader of the ICPP's national scientific organizing committee and the ICPP's Primary Host Institution in Kenya. Egerton University is a premiere institution in agricultural research and training in east and central Africa.

The African Academy of Sciences (AAS), is an Africa-wide, non-profit organization of senior scientists, science policy experts and science managers. AAS' vision is to be the engine driving scientific and technological development in Africa. AAS seeks to honour science and technology achievers and facilitate development of scientific and technological capacity for science-led development in Africa, promoting excellence and relevance in doing so.

TWAS-ROSSA is the academy of sciences for the developing world (TWAS) Regional Office for sub-Saharan Africa. TWAS' mission is to promote scientific excellence for sustainable development in the South. The main objective of TWAS-ROSSA is to coordinate the efforts to promote the activities of TWAS and its affiliated organisations in Africa. TWAS-ROSSA is hosted by the African Academy of Sciences (AAS).

The Koul Research Foundation is the editorial home of *Biopesticides International*, one of the journals accepting invited papers in a special a conference proceedings issue.

KOAN is a national membership organization for organic agriculture Sector in Kenya. KOAN aims to contribute to improved livelihoods of smallholder farmers through capacity building of farmers to participate efficiently in value chains, improving quality and quantity of organic production and by creating better access to fair traded markets.

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The National Council for Science and Technology is a statutory body tasked with the generation of advice on matters of Science, Technology & Innovation (STI). It carries out formulation, coordination of ST&I policies as well as the promotion and popularisation of science and technology nationally.

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Message from ADAPPT Network, Kenya Chapter

The African Dryland Alliance for Pesticidal Plant Technologies (ADAPPT) is a network for optimising and promoting the use of pesticidal plants for food security and poverty alleviation in Africa.

Funding is from the European Commission EuropeAid ACP S&T Programme, involving the Natural Resources Institute (UK) as the lead partner institution and partners from seven African countries (Ghana, Kenya, Malawi, South Africa, Tanzania, Zambia and Zimbabwe). The overall objective of the ADAPPT Network is to strengthen scientific and technological capacity of African nations to exploit and promote pesticidal plants for agricultural development and poverty alleviation. ADAPPT has several objectives, particularly: training and capacity building, dissemination and promotion of pesticidal plant technologies, investigating sustainable production and use, and developing commercialization and marketing opportunities. Convening a scientific conference to help improve networking and build scientific expertise was a promised output from ADAPPT.

The ADAPPT partners unanimously voted to hold this scientific conference in Kenya, and the idea of the 1st International Conference on Pesticidal Plants was established. Egerton University's involvement in ADAPPT as leader of dissemination activities made it a natural primary host institution for the conference, with Egerton convening a national organising committee (NOC) which identified ICIPE as the perfect place to host the ICPP because of its location, excellent facilities and long history of research on pesticidal plants and chemical ecology. I would very much like to thank all the hard work of the various members of the NOC, the international ADAPPT team and our ICIPE hosts for all the hard work they have done in bringing about what I hope will be a very successful conference. The ICPP would not have been possible without the involvement of many other sponsors, and I am particularly grateful to the AAS-TWAS and our many other sponsors for their generous funding and involvement in the conference.

The 1st ICPP has attracted nearly 100 talks, 30 posters and many displays, with delegates arriving from more than 25 countries representing researchers, scholars, traditional herbalists, farmer organizations, NGO/CBOs, industry and suppliers (scientific & general). I sincerely welcome you to Kenya and wish you a productive time during this first international conference on pesticidal plants.

Dr. Joshua Ondura Ogendo, PhD
ADAPPT Country Coordinator, Kenya
and Chair, ICPP National Organizing Committee

National Organizing Committee (NOC)

Dr. Joshua O. Ogendo	Chair-NOC; Egerton University
Dr. Catherine W. Lukhoba	Secretary-NOC; Univ. of Nairobi
Prof. Job I. Jondiko	Member-NOC; Maseno University
Dr. Edwardina O. Ndhine	Member-NOC; NCST
Ms. Jane B. Omari	Member-NOC; NCST
Dr. Vitalis Ogemah	NOC-Member; MMUST
Dr. Baldwin Torto**Error! Bookmark not defined.**	Member-NOC; *icipe*
Dr. Lucy K. Murungi	Member-NOC; JKUAT
Prof. Ratemo W. Michieka	Member-NOC; Univ. of Nairobi
Prof Alfred C. Kibor	Member-NOC; Egerton University
Prof. Josphat C. Matasyoh	Member-NOC; Egerton University
Dr. Esther Kioko	Member-NOC; NMK
Mr. Phillip K. Bett	Member-NOC; Egerton University
Dr. Joasiah O. Omolo	Member-NOC; Egerton University
Dr. Richard M.S. Mulwa	Member-NOC; Egerton University
Dr. Serge P. Kuate	Member-NOC; *icipe*
Prof. Bockline O. Bebe	Member-NOC; Egerton University
Dr. Monica N. Kinuthia	Member-NOC; Min. State Dev. N-Kenya
Dr. Justus M. Ombati	Member-NOC; Egerton University
Dr. Sabina W. Wachira	Member-NOC; *icipe*
Dr. Alex K. Machocho	Member-NOC; Kenyatta University
Mr. Jackton O. Othira	Member-NOC; Egerton University
Dr. Benjamin A. Gyampoh	Member-NOC; AAS
Ms. Olivia Osula	Member-NOC; AAS/TWAS-ROSSA

ADAPPT Network Partners/International Organizing Committee

Prof. Phillip C. Stevenson	Natural Resources Institute, UK
Dr. Steven R. Belmain	Natural Resources Institute, UK
Prof. Monique Simmonds	Royal Botanic Gardens, Kew, UK
Dr. Brighton Mvumi	Univ. of Zimbabwe, Zimbabwe
Mr. Stephen Nyirenda	DARS, Lunyangwa Res. Station, Malawi
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ADAPPT Network External Advisory Board

Prof Murray B. Isman	Univ. of British Columbia, Canada
Prof. Opender Koul	Koul Research Foundation, India
Prof. Ahmed Hassanali	Kenyatta University, Kenya

Conference schedule at a glance

Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
8.00-8.30	ARRIVAL & REGISTRATION	Registration	Registration	Registration	Registration	DEPARTURE
8.30-9.00		Opening Ceremony and Keynote	Keynote	Keynote	EXCURSION	
9.00-9.30						
9.30-10.00				Symposium 4		
10.00-10.30			Coffee/Tea			
10.30-11.00		Coffee/Tea	Symposium 2	Coffee/Tea		
11.00-11.20		Symposium 1		Symposium 4		
11.20-11.40						
11.40-12.00				Symposium 5		
12.00-12.20						
12.20-12.40						
12.40-1.00			Lunch			
1.00-1.30		Lunch		Lunch		
1.30-2.00			Symposium 3			
2.00-2.20		Symposium 1		Symposium 6		
2.20-2.40						
2.40-3.00						
3.00-3.20						
3.20-3.40						
3.40-4.00						
4.00-4.30			Coffee/Tea	Coffee/Tea		
4.30-4.50		Coffee/Tea	Symposium 3	AAS/TWAS Awards & Closing Ceremony		
5.00-5.30		Symposium 2				
5.30-6.00			Sponsors			
6.00-6.30			Posters		Free time	
6.30-7.00				Free time		
7.00 -7.30		Posters				
7.30-8.00		Welcome cocktail	Free time	Conference Banquet		
8.00-8.30						
8.30-9.00		Free time				
9.00-10.00						
10.00-11.00						
11.00-MIDNIGHT						

Detailed Daily Timetable

DAY ONE: MONDAY 21ST JANUARY, 2013				
MASTER OF CEREMONY: PROF. JOSPHAT C. MATASYOH OPENING SESSION AND KEYNOTE LECTURE MAIN HALL CHAIRMAN/RAPPORTEUR: PROF R.MICHIEKA & DR. C. LUKHOBA				
8.00-8.30	REGISTRATION		NOC secretariat	
8.30-8.35	Dr. J.O. Ogendo		CC ADAPPT KENYA / CHAIR NOC	
8.35-8.40	Prof. P.C. Stevenson		PI ADAPPT NETWORK / CHAIR IOC	
8.40-8.50	Prof. Shaukat Abdulrazak		CEO, NCST	
8.50-9.00	Prof. Berhanu Abegaz		Exec Director, AAS-TWAS	
9.10-9.20	Prof. C. Borgemeister		DG ICIPE	
9.20-9.30	Prof. J.K. Tuitoek		VC EGERTON	
9.30-9.40	Dr. Sally Kosgei, EGH, MP		Minister for Agriculture	
9.40-10.20	Prof Murray B. Isman		KEYNOTE ADDRESS	
10.20-10.30	DISCUSSION			
10.30-11.00	Coffee/Tea Break			
	SYMPOSIUM 1 Pre-Harvest –MAIN HALL & LECTURE ROOM A CHAIRPERSON/RAPPORTEUR: DR. J.O. OGENDO & DR. E. KIOKO			
11.00-11.30	S1-P Prof. Baldwyn Torto			
11.30-11.40	DISCUSSION			
	MAIN HALL CHAIRPERSON/RAPPORTEUR DR.J.OGENDO & DR. E. KIOKO		LECTURE ROOM A CHAIRPERSON/RAPPORTEUR DR. O. MPONDA & MS. J. OMARI	
	PRESENTATION	SPEAKER	PRESENTATION	SPEAKER
11.40-11.50	S1-1	Chidoko P	S1-7	Akanmu AO
11.50-12.00	S1-2	Nyirenda SP	S1-8	Devi NS
12.00-12.10	S1-3	Ukeh DA	S1-9	Ghosh SK
12.10-12.20	S1-4	Shomari SH	S1-10	Mudita I
12.20-12.30	S1-5	Agboyi KL	S1-11	Bandason E
12.2.30-2.40	S1-6	Umoetok SBA	S1-12	Tuey RK
12.40-1.00	DISCUSSION			
1.00-2.00	LUNCH BREAK			
SYMPOSIUM 1 Pre-Harvest continued MAIN HALL & LECTURE ROOM A				
	MAIN HALL CHAIRPERSON/RAPPORTEUR: PROF. J.I JONDIKO & DR. J.O. OTHIRA		LECTURE ROOM A CHAIRPERSON/RAPPORTEUR: MR. J.F. KAMANULA & Ms OLIVIA OSULA	
	PRESENTATION	SPEAKER	PRESENTATION	SPEAKER
2.00-2.10	S1-13	Diourtė M	S1-23	Nampeera EL
2.10-2.20	S1-14	Matata PZ	S1-24	Mudzingwa SK
2.20-2.30	S1-15	Mwatawala MW	S1-25	Anyango AA
2.30-2.40	S1-16	Kariuki ST	S1-26	Caboni P
2.40-2.50	S1-17	Demeke A	S1-27	Igogo JM
2.50-3.00	S1-18	Stevenson PC	S1-28	Kavulani JC
3-10.3.20	S1-19	Okweche SI	S1-29	Ogoche JIJ
3.20-3.40	S1-20	Pofu KM	S1-30	Otieno PC

3.40-3.50	S1-21	MacFoy C	S1-31	Kimurto PK
3.50-4.00	S1-22	Adongo AA		
4.00-4.20	DISCUSSION			
4.20-4.50	Coffee/Tea Break			
SYMPOSIUM 2 Post-Harvest MAIN HALL & LECTURE ROOM A				
4.40-5.10	S2-P Dr Steven Belmain			
5.10-5.20	DISCUSSION			
	MAIN HALL CHAIRPERSON/RAPPORTEUR: PRINCE F. H. ANDAN & P.K. BETT		LECTURE ROOM A CHAIRPERSON/RAPPORTEUR B. MVUMI & R.J. BIRECH	
TIME	PRESENTATION	SPEAKER	PRESENTATION	SPEAKER
5.20-5.30	S2-1	Arnold SE	S2-8	Mutua JM
5.30-5.40	S2-2	Sereme A	S2-9	Kabugi MJ
5.40-5.50	S2-3	Kitonde CK	S2-10	Kamanula JF
5.50-6.00	S2-4	Handsen T	S2-11	Paradza V
6.00-6.10	S2-5	Chikukura L	S2-12	Othira JO
6.10-6.20	S2-6	Asawalam EF	S2-13	Okonkwo EU
6.20-6.30	S2-7	Mokwunye IU	S2-14	Green PWC
6.30-6.50	DISCUSSION			
6.50-7.30	POSTER AND EXHIBITON SESSION			
7.30-8.30	WELCOMING COCKTAIL			

DAY TWO: TUESDAY 22ND JANUARY, 2013				
MASTER OF CEREMONY: PROF. PROF AROP L. DENG KEYNOTE LECTURE-MAIN HALL CHAIRPERSON/RAPPORTEUR: PROF. B.O. BEBE/DR A. MACHOCHO				
8.00-8.30	Registration		NOC	
9.00-9.10	RECAP		ADAPPT –Kenya Chair-	
9.10-9.20	Housekeeping announcements		NOC	
9.20-10.00	Prof Ahmed Hassanali		KEYNOTE ADDRESS	
10.00-10.10	DISCUSSION			
10.10-10.40	Coffee/Tea Break			
SYMPOSIUM 2 Post-Harvest continued MAIN HALL & LECTURE ROOM A				
	MAIN HALL CHAIRPERSON/RAPPORTEUR: PROF P.C. STEVENSON & DR. E. NDHINE		LECTURE ROOM A CHAIRPERSON/RAPPORTEUR: PROF. J.I. JONDIKO & DR. S.P. KUATE	
10.40-10.50	S2-15	Kusolwa PM	S2-23	Ndukwe HC
10.50-11.00	S2-16	Karimi K	S2-24	Mwangi ESK
11.00-11.10	S2-17	Ogendo JO	S2-25	Ogemah V
11.10-11.20	S2-18	Mbongo DB	S2-26	Bett PK
11.20-11.30	S2-19	Nukenine EN	S2-27	Ng'eno LK
11.30-11.40	S2-20	Sanon A	S2-28	Kuate SP
11.40-11.50	S2-21	Mutai J	S2-29	Deng AL
11.50-12.00	S2-22	Mvumi B	S2-30	Wilson K
12.00-12.30	DISCUSSION			
12.30-1.30	LUNCH BREAK			

	SYMPOSIUM 3 Farming, vet. & general MAIN HALL & LECTURE ROOM A			
1.30-2.00	S3-P Mr Eustace G Kiarii			
2.00-2.10	DISCUSSION			
	MAIN HALL CHAIRPERSON/RAPPOURTEUR: Dr. PHOSISO SOLA & DR L.K. MURUNGI		LECTURE ROOM A CHAIRPERSON/RAPPOURTEUR: DR. R. MULWA & DR BENJAMIN GYAMPOH	
2.10-2.20	S3-1	Vermeylen S	S3-9	Emile M
2.20-2.30	S3-2	Chauke MA	S3-10	Naandam J
2.30-2.40	S3-3	Matasyoh JC	S3-11	Fernand T
2.40-2.50	S3-4	Munyua CN	S3-12	Tinrmegson O
2.50-3.00	S3-5	Chikwanda D	S3-13	Kakuhenzire R
3.00-3.10	S3-6	Bilal H	S3-14	Bulungu RC
3.10-3.20	S3-7	Jambo I	S3-15	Nyahangare ET
3.20-3.30	S3-8	Mdangi M	S3-16	Murungi LK
3.30-3.50	DISCUSSION			
3.50-4.20	Coffee/Tea Break			
4.20-4.30	S3-17	Kisanga AC	S3-19	Mudalungu CM
4.30-4.40	S3-18	Odhiambo JA	S3-20	Ratnadass A
4.40-4.50			S3-21	Mburu JN
4.50-5.00	DISCUSSION			
5.30-6.00	Sponsors 1-7(@10min)			
6.00-7.30	POSTER AND EXHIBITON SESSION			

DAY THREE: WEDNESDAY 23rd JANYARY, 2013		
MASTER OF CEREMONY : DR. JOSIAH O. OMOLO KEYNOTE LECTURE & SYMPOSIUM 4 Biopesticide technologies-MAIN HALL CHAIRPERSON/RAPPOURTEUR:PROF. A. KIBOR & MS J. OMARI		
8.00-8.30	Registration	
8.30-8.35	RECAP	ADAPPT –Kenya
8.35-8.40	Housekeeping announcements	NOC
8.40-9.20	Prof. Monique Simmonds	KEYNOTE ADDRESS
9.20-9.30	DISCUSSION	
9.30-10.00	S4-P Prof. Opender Koul	
10.10-10.10	S4-1	Nyalala SPO
10.10-10.20	S4-2	Mutebi CM
10.20-10.30	S4-3	Wainwright H
10.30-11.00	Coffee/Tea Break	
11.00-11.10	S4-4	Zida EP
11.20-11.40	DISCUSSION	
Symposium 5 Commercialisation, policy MAIN HALL. CHAIRPERSON/RAPPOURTEUR: PROF B. TORTO & DR S. WACHIRA		
11.40-12.10	S5-P Mr Paul M. Chege	
12.10-12.20	S5-1	Sola P

12.20-12.30	S5-2	Severine D
12.30-12.40	S5-3	Monda JM
12.40-12.50	S5-4	Lamichhane D
12.50-1.00	S5-5	Magreta R
12.10-12.20	S5-6	Ochieno D
12.20-12.30	S5-7	Innocent E
12.30-12.50	DISCUSSION	
12.50-2.00	LUNCH BREAK	
SYMPOSIUM 6 Propagation, conservation MAIN HALL. CHAIRPERSON/RAPPOURTEUR:DR. C. W. LUKHOBA & DR.J.M. OMBATI		
2.00-2.30	S6-P Dr Patrick Muthoka	
2.30-2.40	S6-1	Mulanda SE
2.40-2.50	S6-2	Diarisso NY
2.50-3.00	S6-3	Ofori DA
3.00-3.10	S6-4	Mwaipaya A
3.10-3.20	S6-5	Zimba N
3.20-3.40	DISCUSSION	
3.40-4.00	Coffee/Tea Break	
AAS/TWAS AWARD CEREMONY MAIN HALL CHAIRPERSON/RAPPOURTEUR:PROF B. ABEGAZ & DR. B. GYAMPOH		
4.00-4.05	Welcome remarks	Dr. Shem Arungu-Olende
4.05-4.15	Announcement and giving prizes	Dr. Shem Arungu-Olende
4.15-4.35	Presentation by 2012 TWAS Regional Prize Awardee	Prof. Charles N. Wambebe
4.35-4.55	Presentation by TWAS-ROSSA Young Scientists' Prize Awardee	Dr. Emmanuel I. Unuabonah
4.55-5.35	Public Lecture	Prof. Charles O. N. Wambebe
CLOSING CEREMONY CHAIRPERSON: PROF R.W. MICHIEKA & DR MONICA KINUTHIA		
5.35-5.45	Dr. J.O. Ogendo	CC ADAPPT-KENYA/Chair NOC
5.45-5.50	Prof. P.C. Stevenson	PI ADAPPT-NRI/Chair IOC
5.50-6.00	Prof J.K. Tuitoek	VC-EGERTON
6.00-6.10	Prof C. Kiamba	GUEST OF HONOUR: PS, MoHEST
6.10-6.20	Ms Jane B. Omari	VOTE OF THANKS
7.20-MIDNIGHT	CONFERENCE BANQUET CHAIRPERSON: DR J. OGENDO	
8.00-6.00	DAY FOUR: THURSDAY 24TH JANUARY, 2013 EXCURSION(LAKE NAKURU NATIONAL PARK)	

List of Abstracts

Key note speakers

[KN1] Harnessing pesticidal plant technologies for improved livelihoods

Professor Murray Isman
Dean, Faculty of Land and Food Systems, University of British Columbia, Vancouver, B.C., Canada, V6T 1Z4
Email: murray.isman@ubc.ca

Stringent regulatory requirements governing the use of pesticides in G20 countries have created renewed interest in insecticides based on natural products, including botanical insecticides. Commercialization of neem (azadirachtin)-based insecticides in the 1990s and pesticides based on plant essential oils in the past decade have raised the profile of botanicals and demonstrated their utility in certain pest management contexts. However the numbers of successful botanical insecticides in use are dwarfed by the volume of research publications on this subject, based on recent bibliometric analyses, suggesting a big "disconnect" between theory and practice. Botanical insecticides may lack the absolute efficacy and residual action of many conventional insecticides, but they are finding increasing acceptance in situations where human health is of primary concern. These include urban environments – for control of domestic and public health pests, and controlled environments such as greenhouses. Other uses in the Northern Hemisphere include ectoparasite management on companion animals and domesticated livestock, mosquito abatement, and as personal repellents against blood-feeding arthropods. In developing countries, where regulatory pressures and enforcement are less stringent, botanicals appear to enjoy more widespread use in agriculture, although this is quite difficult to track. Many tropical plants have insecticidal properties, are readily available locally at little or no cost, and can be used with minimal preparation. As the vast majority of pesticide-related poisonings and deaths occur in developing countries, it is in these countries that the benefits of botanical insecticides are best realized. While there is academic interest and pressure to find additional novel plant sources of natural insecticides, I argue that we already have enough candidate plants available to improve the livelihoods of smallholder farmers in sub-Saharan African; greater emphasis should be placed on demonstrating the practical utility of these plants and simple plant preparations useful for pest management.

[KN2] Pesticidal plant bio-prospecting: ethno-veterinary and vector control

Professor Ahmed Hassanali
Chemistry Department, Kenyatta University, P O Box: 43844-00100, Nairobi, Kenya
Email: azhassanali@gmail.com

The presentation will outline on-going studies on two disease vectors: *Anopheles gambiae*, which transmits malaria, and *Rhipicephalus appendiculatus*, which transmits a cattle disease known as East Coast Fever (ECF). Both sets of studies included research on the efficacy of phytochemicals-based ethno-practices for the control of the vectors and explored methods of improving upon these. However, R&D in the development of effective vector control strategies constitutes a multi-disciplinary subject. The presentation will highlight the importance of 'bio-rational' R&D approaches that integrate bioprospecting for active phytochemicals with behavioural/physiological manipulation of the target vectors and chemo-ecological insights and tools. Fruitful bio-prospecting also needs to take into account consequences of co-evolutionary interactions mediated by secondary metabolites between plants and their predators. Important consequences of such interactions include (i) structural and analogue diversity of compounds often acting as blends to provide effective protection against specific predators and to mitigate against speedy resistance development; and (ii) subtlety in the actions of secondary metabolites, often relying on repelling/deterring specific functions of predators or inhibiting their normal physiology and development, and rarely on their acute toxicity. These have important implications on experimental approaches used to discovering potentially useful phytochemicals and to their effective exploitation.

[KN3] Plants-derived compounds in pest control: challenges and opportunities

Professor Monique Simmonds
Jodrell Laboratory, Royal Botanic Gardens, Kew, Richmond, Surrey, UK
Email: m.simmonds@rbgkew.org.uk

Despite the interest in plant-derived compounds for the control of pests very few have been developed as commercial products. It is clear that the compounds in plants have a significant influence on the selection behaviour of insects and as antifungal agents yet why are so few used in pest control? This talk will provide an overview of some of the challenges, both legal and scientific, that need to be addressed in the development of a product for pest control. Challenges will vary depending if the products are for local use or for the commercial market. Traditionally the companies have been interested in the development of compounds that will show selective toxicity against target organisms. This is still an important objective but they are also showing more interested in integrated approaches to pest control that involve finding new products that modulate the behaviour of pests. This could include the use of defined plant extracts, not just single compounds. Our increased knowledge about the ecological role of plant-derived extracts/compounds in plant-pest interactions could open the door to an increased use of natural products in pest control strategies. However, in the development of products the scientist has to cover issues that relate to the access of biological resources for testing and to the use of any intellectual property about the traditional uses of these resources. The main international agreements that relate to intellectual property about the uses of plants are "Trade-Related aspects of Intellectual Property rights (TRIPS) and the Convention on Biological Diversity (CBD) (www.cbd.int). These agreements differ fundamentally in their approaches to intellectual property. This talk will be illustrated by work done at Kew and in collaboration with others on the importance of dealing with these international agreements at an early stage of a project. Greater knowledge about how to deal with these treaties in the early stages of a project should assist scientists focus on finding robust new leads and mitigate the potential of being called a biopirate should they discover the next international pesticide or a local control agent that they want to share with their colleagues in other countries.

Symposium 1 Pre-harvest Plenary

[S1-PL] Exploiting plant volatile semiochemicals in the control of pests and disease vectors

Prof. Baldwyn Torto
Principal Scientist and Head of the Behavioural and Chemical Ecology Department, ICIPE, Nairobi, Kenya
Email: btorto@icipe.org

Plant biochemical processes lead to the release of volatiles comprising hundreds of chemicals. Some of these chemicals play important plant fitness enhancing functions, such as attracting pollinators or recruitment of natural enemies. They may also be exploited by phytophagous insects as cues to guide them to their food and egg-laying sources and to find their sexual partners. For a good understanding of the interaction between insects and plants requires knowledge of insect olfaction. Olfaction studies show that only a fraction of plant volatiles are detected by antennae of an insect, with an even smaller number of these chemicals eliciting behavioural activity. Understanding the chemical mechanisms that underlie insect-plant interactions provides a novel opportunity to exploit these chemical cues in the management of crop pests and disease vectors. Examples of studies involving exploitation of plant volatile semiochemicals in the control of pests and disease vectors will be provided.

Symposium 1 Pre-harvest Session talks

[S1-1] Evaluation of the efficacy of aqueous extracts of *Allium sativum, Albizia versicolor* and *Lantana camara* for the control of coffee leaf rust, *Hemileia vastatrix* B & Br

Chidoko P
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Coffee leaf rust, caused by *Hemileia vastatrix* B & Br., causes economic losses of up to 80% in plantations if uncontrolled. An experiment was carried out to evaluate the efficacy of three botanicals: garlic (*Allium sativum*), Lantana (*Lantana camara*) and Albizia (*Albizia versicola*) at Coffee Research Institute laboratory, Chipinge, Zimbabwe. The experiment was laid out in a completely randomized design with three replications. Aqueous leaf extracts for each botanical were prepared into concentrations of 100%, 50%, 25% and 12.5%. Copper oxychloride 85% WP at 10g/litre water was used as the standard and distilled water as the control. A spore suspension of *H. vastatrix* was prepared for germination in petri dishes containing Potato dextrose agar and each botanical in three separate experiments. Germinated spore counting was done by microscopic examination of 100 spores per slide after incubating for 16 hours. There were highly significant differences in leaf rust spore germination due to garlic, lantana and albizia concentrations ($P<0.001$). Copper oxychloride and the neat extract (100% aqueous extract) were not significantly different in all botanicals tested. Distilled water (control) was not effective in inhibiting spore germination and was significantly different from the rest of the treatments. The results showed that efficacy of the extracts increased with increase in concentration for all the three botanicals. Garlic, lantana and albizia showed great potential in controlling coffee leaf rust under laboratory conditions. More work needs to be done on how these botanicals can be used in integrated disease management programmes with specific reference to coffee leaf rust.

[S1-2] Participatory field evaluation of selected pesticidal plants for management of vegetable pests in Malawi

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Tomato (*Lycopersicon esculentum*) and rape (*Brassica napus*) are probably the most important horticultural vegetable crops grown in Malawi and the southern African region. However their production is highly constrained by insect pests. Farmers rely primarily on the use of synthetic pesticides to manage insect pests such as red spider mites (*Tetranychus evansi*) and aphids (*Brevicoryne brassicae* and *Myzus persicae*) in their fields. In this study, five dried pesticidal plant aqueous solutions; *Tithonia diversifolia*, *Azadirachta indica*, *Tephrosia vogelii*, *Solanum panduriforme* and *Vernonia amygdalina* were evaluated at the rate of 5% in comparison to Phoskil, Dimethoate and untreated control through participatory farmer field trials for the management of red spider mites, aphids and other pests on tomato and brassicas in Malawi. The results suggest that pesticidal plant extracts had significantly higher effect on controlling red spider mites and aphids. Amongst the plant extracts, *T. diversifolia* recorded the lowest mean number of red spider mites (31) and aphids (7) compared to untreated control (51 and 103). Lower mean tomato fruit damage were recorded on *T. diversifolia* (20%) and *Vernonia amygdalina* (15%) compared to control (47% and 32%) at Jenda and Nchenachena in 2008 season. Highest mean tomato yields (30,883; 16,862 Kg ha^{-1}) were obtained at Jenda compared to control (15, 176 and 15, 117 Kg ha^{-1}) for 2008 and 2009 seasons respectively. Moreover, these pesticidal plant materials had no effect on vegetative growth of tomato and rape plants. The results obtained indicate that the use of the pesticidal plant materials can play a significant role in improving vegetable production for the resource-poor farmers without relying on conventional pesticides.

[S1-3] Differential responses of the cowpea aphid, *Aphis craccivora* to host plant and pesticidal plant odours

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Cowpea, *Vigna unguiculata*, is an important leguminous food crop that provides a relatively inexpensive source of high quality protein for humans and animals in many tropical countries. The cowpea aphid, *Aphis craccivora*, is a key pest of this crop. Olfactometric experiments were conducted in the laboratory to study the influence of host plant and pesticidal (non-host) plant odours on apterae and alatae of *A. craccivora*. The host plants were *V. unguiculata* and groundnut, *Arachis hypogea* fresh leaves, while the non-host plants were neem, *Azadirachta indica* and Pepper fruit, *Dennettia tripetala* seed oils. Both apterae and alatae significantly ($P<0.001$) spent more time and made more number of visits to the arm of olfactometer emitting host plant odours compared to control in single choice bioassay. In response to non-host odour perception, the aphids significantly exhibited avoidance behaviour in time spent and number of visits compared to the control. When *V. unguiculata* and *A. hypogea* volatiles were compared in a dual choice test, the time spent by apterae and alatae in the two olfactometers was significantly greater than the time spent in the control arms. However, the aphids did not show any preference for either of the two treatments, thus demonstrating that both sets of volatiles have similar attractivity. The aphids were also significantly ($P< 0.001$) repelled by *A. indica* and *D. tripetala* volatiles compared to control arms in choice tests. This study showed that *A. craccivora* responded with positive anemotaxis to kairomonal cues emanating from its host plants, *V. unguiculata* and *A. hypogea*, but was repelled by non-host volatiles. The result indicate that *A. indica* and *D. tripetala* oils have potential as repellents or a part of the integrated pest management strategies in the control of *A. craccivora* by resource-poor farmers in the tropics.

[S1-4] Screening botanicals with control potential against cashew powdery mildew disease in Tanzania

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Five potential botanicals locally named Kimbinga, Mnyaa, Muarobaini, Lipangati, Kibamba were screened against cashew powdery mildew disease caused by the fungus *Odium anacardii* during 2012/2013 cashew season at Naliendele Research Institute. Six cashew trees were picked from a cashew block and on each tree, ten shoots were selected and tagged. Each potential botanical to be tested including control was assigned to one tree. Extract solutions of these botanicals were made every week from 24th to 16th September 2012 and sprayed to the flower panicles of the previously tagged shoots on the respective trees followed by the assessment of the disease. The final disease assessment showed that panicles sprayed with Mwarubaini scored the lowest infection level (31.5%), followed by Kibamba (35.5%), Mnyaa (36.5%) and Lipingati (41.8%). Statistically there was a significant difference (p=0.05) between these four treatments compared to the control. Kimbinga attained the highest mildew infection level (80.8%) which was close to the 100% level scored on the control flower panicles. These preliminary results indicate that the four botanicals Muarubaini, Kibamba, Mnyaa and Lipangati appear to have some potential in controlling powdery mildew disease on cashew. Further work will be conducted in the coming cashew seasons to ascertain the performance of these botanicals in managing mildew disease on cashew.

[S1-5] Comparative effect of neem seed kernel extract and two synthetic insecticides against the new major pest of sorghum, *Poophilus costalis* in Togo

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The improved variety of sorghum Sorvato 1 bred in 1996 in Togo and introduced in the northern part of the country to increase the yield and circumvent the shortening of the rain season is confronted together with local varieties since 2000 by severe attacks of *Poophilus costalis* (Walker) (Hemiptera: Aphrophoridae). In a control program of the pest, bioassays with a population of *P. costalis* from Dapaong, Togo were conducted. The experiments were carried out at the same time in laboratory and field, using Neem (*Azadirachta indica*) seed kernel extract (local material), Cypermethrin and Carbofuran. In laboratory, the three insecticides were tested against the third instars (L_3) of P. costalis but, in field, all the development stages of the pest were targets. The result indicated a high efficacy of neem kernel extract, Cypermethrin and Carbofuran to control *P. costalis*. The LC_{50} for neem kernel was 16337.70 mg/l and those of Cypermethrin and Carbofuran were respectively 2.26 mg/l and 6.80 mg/l. On field experiment, the use of 8000 g/ha of neem kernel, 50 g/ha of Cypermethrin and 35 g/ha of Carbofuran contributed to the reduction of the population of *P. costalis* respectively by 73%, 87% and 94%. Compare to the synthetic insecticides, neem seed kernel extract is a promising natural insecticide for sorghum protection against *P. costalis*. Further field experiments with more important doses of neem seed kernel are necessary for best recommendation to farmers.

[S1-6] The efficacy of biopesticides in the control of American cockroach, *Periplanata americana* in Nigeria.

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Two laboratory trials were conducted to evaluate the efficacy of neem (*Azadirachta indica*) and Gmelina (*Gmelina arborea*) seed extracts for the control of the American cockroach (*Periplanata americana*). The first experiments consisted of four levels (0, 5, 10 and 15g) Gemlina (G) and neem (N) seed paste mixed with 20 g of bread and applied as food. The second experiment consisted of extract solutions of the same levels (0, 5, 0, 15 g) of Gemlina and neem seeds but applied as spray using hand sprayer biweekly for 42 days. In both experiments 20 (synchronized 180 days) old adults placed in cages were used. The experiments were laid out in a 4 x 4 factorial arrangement in a complete randomized design (CRD) and replicated four times. Significantly ($P<0.05$) mean % mortality of 90.7 and 80 were recorded in the G15N15 and G10N15 treatments combinations used as food respectively. No mortality was obtained in the control G0N0. The same trend was observed in the spray experiment where significantly ($P<0.05$) higher adult % mortality was recorded in the treatments applied with G15N15 (96.67) having the highest % mortality. Significant difference ($P< 0.05$) was observed in the % adult weight loss in the treated experiment with G15N15 and G15N5 treatment combinations recording the highest (59.91 and 59.42) which could be attributed to cessation of feeding by the insects due to anti-feeding and repellent properties of the treatments applied. This study showed that neem and Gmelina products used as treatments in the spray form can control *Periplanata americana*.

[S1-7] Botanicals inhibited *Fusarium* pathogens of millet

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The global call on the use of botanicals as phyto-fungicides has not really being given attention in Africa most especially on Fusarium pathogens causing diseases of Millet. This study investigated the effects of aqueous extracts of *Mangifera indica* and *Jatropha curcas* at different concentration levels (15, 30 and 45% mg/ml) on Fusarium pathogens. The phytofungicidal effects of *M. indica* and J. curcas were assessed both in vitro and in vivo on *F. anthophilum*, *F. verticilloides*, *F. oxysporum* and *F. scirpi*. The aqueous extracts of M. indica and J. curcas at different concentration levels (15, 30 and 45% mg/ml) were prepared using standard method. The in-vitro and in-vivo antagonistic experiments were carried out using mycelia disc and simultaneous inoculation method respectively. The experimental layout in the screenhouse (in-vivo) was complete randomized design with three replications. Data on percentage mycelia inhibition, disease incidence and severity were obtained, assessed and statistically analysed using Minitab version1.5. Based on the in-vitro experiment, J. curcas significantly ($P<0.05$) inhibited the mycelia growth of the Fusarium pathogens at increasing concentrations compared to *M. indica* that was only significantly ($P<0.05$) effective at 15 and 30% mg/ml concentration. The in-vivo showed that *J. curcas* at 15, 30 and 45% mg/ml concentration significantly ($p<0.05$) controlled *F. anthophilum*, *F. verticilloides* and *F. oxysporum*. Also, *M. indica* at 30 and 45% mg/ml concentration was observed to be significantly ($p<0.05$) effective on F. verticilloides and *F. scirpi*. Generally, both *J. curcas* and *M. indica* significantly ($p<0.05$) reduced the disease incidence and severity caused by *F. anthophilum* and *F. oxysporum* at the concentrations tested compared to the controls. These botanicals were considered effective on Fusarium pathogens causing diseases of millet. Hence, they could be employed in large scale farming geared towards sustainable millet production in Nigeria.

[S1-8] Antifungal activity of some botanical oils against *Alternaria solani*, causing leaf blight of potato under Indian condition

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The inhibitory effects of five botanical oils (Neem, Citronella, Pine, Clove and Garlic) at 0.05%, 0.1% and 0.15% concentrations along with sole application of solvent xylene were tested under in vitro condition. Four isolates (A1, A2, A3 and A4) of *Alternaria solani* were collected from different potato growing areas of West Bengal, India. Significant antifungal activity of these five botanical oils against four isolates of *A. solani* were noticed. Garlic (0.15%) inhibited the mycelial growth of A1 (90.32%), A2 (91.17%), A3 (87%) and A4 (89.67%). Spore germination was also inhibited due to application of Garlic (0.15%) in case of A1 (79.52%), A2 (86.47%), A3 (81.87%) and A4 (84.30%) isolates. Next best results were obtained due to application of Neem oil (0.15%) where, inhibition of mycelial growth (84.42%, 86.53%, 83% and 82.90% for A1, A2, A3 and A4 isolates respectively) and spore germination (72.96%, 77.60%,74.92% and 80.47% for A1, A2, A3 and A4 isolates respectively) were significantly different. Hence, out of five botanical oils, Garlic (0.15%) exhibited maximum inhibition of mycelial growth and spore germination over control including sole application of solvent xylene. Field studies conducted under artificial inoculation conditions also reveal that, two sprays of Garlic oil (0.15%) not only suppressed the Alternaria Leaf Blight infection but also enhanced the tuber yield. Findings from this study confirm that, botanical oils should be used as non-hazardous natural fungicides in controlling plant pathogenic fungi, thus reducing the dependence on the synthetic fungicides.

[S1-9] Efficacy of plant extracts against aphids (*Myzus persicae* Sulzer and *Aphis gossypii* Glover together) infesting potato (*Solanum tuberosum* L.)

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Potato (*Solanum tuberosum* L.) is cultivated in India in a commercial scale and this crop is susceptible to various insect pests of which aphids (both *Myzus persicae* Sulzer and *Aphis gossypii* Glover) cause heavy damage especially by spreading virus diseases. Studies were made to evaluate efficacy of extracts from plants such as *Pongamia pinnata* L. and *Nicotiana tabacum* L. and *Polygonum hydropiper*, botanical insecticide such as azadirachtin (1500ppm), against aphids infesting potato crop under field conditions of the sub-Himalayan region of north-east India during the rabi season. Methanol was used as solvent for extracting from fruits of Pongamia and floral part of Polygonum and water for leaves of *N. tabacum*. Imidacloprid (Confidor 17.8 SL) was used as check. Three sprays at 10-day intervals were made, starting with the initiation of infestation. Total aphid numbers (nymphs and adults of both aphids together) per plant were counted at 4 and 9 days after treatment (DAT). The data thus obtained were converted to the per cent reduction of the aphid population and analysed statistically. Imidacloprid was found the most effective treatment for controlling aphid, followed by plant extract of Polygonum flower at 5 % concentration. From overall observation it was revealed that plant extract of Polygonum flower at 5 % concentration and tobacco leaf extract at 10 % concentration gave satisfactory result, recording more than 70 % and 65 % aphid suppression respectively. The botanical insecticide azadirachtin was also found very effective against aphid, achieving more than 60% suppression. Plant extracts and botanical insecticide are biopesticides having less or no hazardous effects on human health and the environment, and therefore, they can be incorporated in IPM programmes and organic farming.

[S1-10] Preliminary studies on the effectiveness of thorn apple (*Datura stramonium* L.) against aphids (*Aphididae* spp.) on rape (*Brassica napus*) under smallholder farming systems

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A study was carried out to explore possibility of using thorn apple (*Datura stramonium* L.) to control aphids in rape under smallholder farming systems. The objectives of the study were to evaluate effects of different levels of thorn apple application on aphids and to determine effects of the different levels on rape leaf yield. Thorn apple powder was mixed with one litre of water and sprayed four WACE (weeks after crop emergence). Five treatments from 0 g to 8 g in increments of 2 g were tested. The experimental design used was a completely randomized design) with the five treatments replicated 4 times. There was a significant difference ($P \leq 0.05$) in aphid counts among all treatments at week 5, 6 and 7, with 8 g treatment resulting in the least aphid counts while the control (0 g) and 2 g treatments resulted in the highest counts. At week 8, the least counts were recorded in the 4 g, 6 g and 8 g treatments, which were significantly different from the control and 2 g treatments. Overall mean aphid counts showed a reduction in aphid counts with an increase in the amount of thorn apple powder applied. Rape leaf yield increased with increase in the amount of thorn apple powder applied from the control (5750kg/ha) to 6 g thorn apple powder (23750kg/ha), but leaf yield reduced at 8 g treatment (13000kg/ha). High concentration (8 g) effectively controlled aphids but resulted in severely scorched leaves, reducing both quality and quantity of yield. The study showed that thorn apple effectively controls aphids, with better results obtained with 6 g thorn apple powder in one litre of water. Suggestions for future research are to repeat the experiment and investigate effects of the spray mixture on human health.

[S1-11] Evaluating efficacy of fresh leaf extract *Tephrosia vogelii* with and without soap in the control of aphids, forage thrips and jassids in cowpeas

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One of the challenges in agricultural production is costly management of insect pests, using synthetic insecticides which are not readily available for the local farmers. This study presents an attempt to assess the effectiveness of different concentrations of Tephrosia vogelii crude leaf extracts with and without soap in control of aphids, forage thrips and jassids in cowpeas. The major findings that emerged were as follows: a) no significant differences in insect pest populations before treatment, b) with respect to the concentration of the extract (with soap and without soap) there was varying effectiveness of the extract against insect populations at $P<0.05$ c) high insect pest reduction in Tephrosia extract mixed with soap at $P<0.05$ d)varying efficacy of the extract (with and without soap) on different insect pests) observed burnt leaves in plants treated with high concentration of soap. The study has shown that Tephrosia leaf extract mixed with soap is more efficient that the one without soap and the efficacy varies with insect pest species. Further investigations on the selective toxicity of the extract are recommended. Moreover, investigation of soap and the leaf extracts residues on the plants cannot be over emphasised.

[S1-12] Use of Pymarc in management of bean fly (*Ophiomyia* spp) on common beans (*Phaseolus vulgaris* L.)

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Bean fly (*Ophiomyia* species) is a major pest of common beans (*Phaseolus vulgaris* L.) causing up to 100% yield losses, during dry seasons. Use of chemical sprays to control bean fly on beans has been used by farmers with limited success. The high cost of chemicals, lack of information on application procedures and environmental pollution are some of reasons for low adoption. An alternative management procedure exploiting the principle of cultural control, a seed dress insecticide and use of Pymarc (a by-product of pyrethrum) were investigated. The experiment was conducted at Kenya Agricultural Research Institute (KARI), Njoro. Phosphorus applications at three levels: 0, 40 and 80P_2O_5 kg/ha; Pymarc applied on leaves and Gaucho 350FS as a seed dress were evaluated. The evaluation was on bean fly population, damage and yield of beans on two bean varieties. Randomised Complete Block Design in split-split plot arrangement replicated thrice was applied. Results showed that Pymarc and gaucho 350FS significantly ($P< 0.05$) reduced bean fly population and damage. Gaucho 350FS reduced plant mortality significantly ($P< 0.05$), while Pymarc enhanced yields during the long than short rains seasons. Red haricot was 'resistant' to bean fly infestation recording lower plant mortality and higher yields than Rosecoco. Thus, application of Pymarc has a potential to reduce bean fly damage and improve bean yields.

[S1-13] Effectiveness of vegetable extracts in seed treatment against covered smut and other sorghum pest in farmers' fields in Mali

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Studies on the effectiveness of vegetable extracts in seed treatment against covered smut, *Sporisorium sorghi*, and other sorghum pests were conducted from 1999 to 2001 in station and in farmers' fields. The objective of the studies was to improve farmer practices of sorghum seed treatment. Results indicated that extracts of plants pesticides Diro (*Securidaca longepedunculata*), Nguo (*Canavalia ensiformis*) and the hull of néré (*Parkia biglobosa*) was the best. In station, the treatment of seeds with the powder of these extracts at 10 g/kg of sorghum seeds caused a yield increase of 30%while controlling covered smut. In 34 farmer fields at Kolokani and Bamamba in 2000 and 2001, Séguétana CZ, striga tolerant local improved variety, treated at 20 g/kg of seeds with these extracts controlled perfectly the covered smut while causing a yield increase varying from 30 to 67%. These extracts did not affect significantly the evolution of the insects leading to the dead hearts of sorghum plants or on the infestation of striga. Tests on the adhesion of the powder of the extracts to sorghum seeds with arabic gum or other products will enable this vegetable extracts formula to be efficiently used.

[S1-14] Effect of neem cake on root-knot nematode infestation in field crops: A case study of Tabora, Tanzania

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The yield loss of major crops in these regions due to nematodes is estimated to be 12.3%, which is higher in developing countries than developed ones due to a variety of reasons including increased diversity of nematode genera and their higher fecundity rate due to their shorter life cycle, higher temperature, longer growing seasons, the absence of winter chilling, unawareness about nematode problems, and lack of proper management practices. The losses caused by nematodes can be managed by soil fumigation with nematicides and by using resistant plants. The objective was to assess the effect of neem cake on root-note nematode infestation in field crop. Tomato seedlings infected with root-knot nematode were sown at the experiment plots to ensure uniform infection of nematodes in the soil. Plot sizes were 1m x 2m arranged in a completely randomized block design with four replications. Before application of the neem cake, 10 soil samples were taken randomly from each plot at 0-15 cm depth to determine the initial soil nematode population. Nematode populations were determined by bioassay techniques. Control treatments involved Ethylene dibromide (Edb) and untreated plots. There were no significant differences observed in soil nematode population from various treatment plots before application of the cake. This indicates that all plots were adequately infested with nematodes. There were no significant differences observed in soil nematode population from various treatment plots before application of the cake. This indicates that all plots were adequately infested with nematodes. Three days after application treatments, significantly ($P<0.05$) differences in soil nematode population were observed. The results confirm our previous findings that neem cake at a higher rate of application could be used effectively to control root-not nematode in tobacco nurseries and replace the Edb which is an expensive chemical and not readily available to the farmers.

[S1-15] Incorporating a botanical based bait in an integrated pest management program of fruit flies (Diptera: Tephritidae) attacking mangoes in Tanzania

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Trials were conducted in eight selected orchards located in the mango growing areas of Morogoro Region, Tanzania, to evaluate the effectiveness of a fruit flies IPM program containing botanical based bait. The treatments included (i) orchard sanitation (ii) orchard sanitation + spray of dimethoate 480EC + early harvesting (iii) orchard sanitation + spray of GF 120 containing 0.02% spinosad + male annihilation using methyl eugenol and early harvesting (iv) orchard sanitation + spray of a locally formulated bait (containing crude extracts of *Derris elliptica* as a toxicant) + early harvesting. Each treatment was applied in an individual orchard and replicated twice. Populations of fruit flies in each orchard were monitored using torula yeast placed in McPhail traps. A total of six traps were placed in a selected one hectare area. The replication of traps within each site were sub-sampled to construct point wise biased and accelerated bootstrap confidence intervals that were used to compare treatments. Further, fruits were sampled at ripening and individually placed in containers to determine incidences and infestation rates of emerged fruit fly species. The IPM program containing locally formulated bait has shown potential for reducing incidences and infestation rates of fruit flies in mango. Furthermore, there were no significant differences in abundances of fruit flies between the packages for most parts of mango season.

[S1-16] Participatory research on the effectiveness of stinging nettle as a biopesticide in Kenya

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Globally 50% of all food and cash crops are lost to pests and diseases. The participatory research has been used for the control of crop pests and diseases in developing countries. A field study was carried out in Kamweti village of Kirinyaga County. The objectives of the study were: to identify training needs on sustainable agriculture through carrying out needs assessment consultative workshops and to investigate the effect of stinging nettle as a bio-pesticide in the common vegetables. Twenty three training workshops were carried out to train farmers on sustainable agriculture principles. Twenty eight soil samples were tested for pH, nitrogen, phosphorus and potassium. From the soil analysis, 95% of the soil samples had low nitrogen and phosphorus levels, high potassium levels and were slightly acidic. The pesticidal effect of stinging nettle was tested by comparing fresh biomass weight, plant growth, pest damage levels and abundance of pest species. Two treatments were arranged in a Generalized Randomized Block Design (GRBD) with four replications per treatment. Stinging nettle biopesticide showed a significant reduction in pest damage levels on the treated plots in comparison to the control. However, there were no significant differences in biomass weight and plant height between the plots treated with the stinging nettle biopesticide and the control. A total of 12 arthropod species belonging to five orders were observed with aphids being the most abundant species noted in the field. It was concluded that application of Stinging nettle extract reduced the crop losses due to pest damage and increased marketable yield for consumption and profit to smallholder farms in Kenya. From this study, it was recommended that further work need to be done on stinging nettles on different crop pest and in in different ecological areas.

[S1-17] Efficacy of some botanicals on stem borers *Busseola fusca* Fuller and *Chilo partellus* Swinhoe on sorghum in Ethiopia under field conditions

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Two lepidopteran stem borers, the maize stem borer, *Busseola fusca* Fuller (Lepidoptera: Noctuidae) and the spotted stem borer, *Chilo partellus* Swinhoe (Lepidoptera: Crambidae) are the primary pests of sorghum in Ethiopia. Studies on management of these stem borers using botanical pesticides on sorghum were conducted at Sirinka and Chefa, north-eastern Ethiopia in 2009 and 2010. The experiments were designed in randomized complete block with three replications. Botanicals from *Tanacetum cinerariaefolium*, *Nicotiana tobacum*, *Azadirachta indica*, *Jatropha curcas*, *Cissus quadrangularis*, *Chenopodium ambrosioides* and *Euphorbia schimperiana*. *T. cinerariaefolium*, *N. tobacum*, *J. curcas* and *E. schimperiana* were better than the standard and untreated controls in reducing damage and increasing yield. Percent damage of sorghum was significantly ($P<0.0001$) reduced from 66–95% in control to 3–19%, 3-15%, 2-10% and 7–15%% in *J. curcas* seed powder, *T. cinerariaefolium* flower powder, *N. tobacum* leaf powder and *E. schimperiana* leaf powder treatments, respectively, in all locations and years. Significantly higher yield was recorded on sorghum treated with these botanicals than the untreated control and the rest of the botanicals. Sorghum yield advantages of 46-69%, 48-63%, 49-57% and 39-63% over the untreated control were recorded in *J. curcas* seed powder, *T. cinerariaefolium* flower powder, *N. tobacum* leaf powder and *E. schimperiana* leaf powder treatments, respectively. The results suggest that powder form of different parts of these plant species can be used for the management stem borers on sorghum.

[S1-18] Phytochemical variation: a limiting factor in pesticidal plant applications for small holder farmers in Africa

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Recent surveys of small-holder farmers in Africa indicate that plants are still valued for insect pest control. However, we identified high levels of chemical variability in several pesticidal plants species which was unnoticed by farmers and led to widespread application of ineffective plant materials. We have shown that *Tephrosia vogelii*, a widely used pesticidal plant that is also grown in fallows to enrich soil, occurs as two distinct chemotypes. Chemotype 1 contained rotenoids, including deguelin and tephrosin which were responsible for the pest control efficacy whereas rotenoids were absent from chemotype 2, which was characterised by prenylated flavanones that are biologically inactive against the insects we tested. Sampling from 13 locations in Malawi where farmers cultivated T. vogelii for insecticidal use indicated that 25% of plants were chemotype 2 and so were unsuitable for this application yet were still being used for pest control.

[S1-19] Comparative efficacy of pesticidal plant products and Carbofuran in the management of maize stem borers in Nigeria

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Field experiment was conducted in the early and late planting season of 2009 and 2010 to evaluate the efficacy of two pesticidal plants namely, *Azadirachta indica* and *Gmelina arborea* against stem borers of maize in Nigeria. The treatments consisted of 2 levels of synthetic insecticide, Carbofuran (1.0 and 1.5kg a.i/ha) and 2 levels each of *A. indica* and *G. arborea* seed powder (20 and 30kg/ha). Treatments were laid out in a randomized complete block design (RCBD) with 3 replications. Result showed that *A. indica* and Carbofuran significantly ($P<0.05$) reduced the stem borer population and other damage indices than the *G. arborea* seed powder. The efficacy of pesticidal plant was similar to that of Carbofuran in the control of stem borer infestation. In conclusion, *A. indica* has potential as an alternative to synthetic insecticide in the management of stem borers by resource poor farmers in the tropics.

[S1-20] A ground leaching technology for application of bio-nematicides from indigenous plants in smallholder farming systems of South Africa

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In ground leaching technology (GLT), powdered plant materials from selected organs are applied around the stem inside of a shallow hole at 5 g/plant during transplanting for managing the root-knot (*Meloidogyne* spp.) nematodes. The objective of the study was to outline the technology, its successes, failures and compatibility with other technologies in crop production. The unique features of GLT are that the ground materials are (1) used in small quantities, (2) manually applied at transplanting around the seedling and (3) water-dependent for their efficacy in nematode suppression. The application interval is 56 days, suggesting in crops with longer season repeat application would be necessary. The success of the technology is dependent upon the selected material, with other materials being unsuitable since they reduce soil pH or require microbial degradation to release potent chemicals. In South Africa, fruits of wild cucumber (*Cucumis myriocarpus*) have been successful in GLT, since the material had no effect on soil pH, but reduced nematode numbers from 70% to over 90%. In conclusion, the material has the ability to suppress *Meloidogyne* species, particularly during soil stages.

[S1-21] Insecticidal Activity of *Cucurbita pepo* and *Mammea africana*

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Alcohol extracts of two tropical plants from Sierra Leone, *Cucurbita pepo* and *Mammea africana*, were tested for insecticidal activity against the larvae of the fruit fly, *Drosophila melanogaster*, using the residual deposit and the incorporation methods respectively. Both plant extracts showed insecticidal bioactivity; however the *M. africana* extract was more active, with a lower LD_{50} than the *C. pepo* extract in both bioassay methods. The potential for developing environmentally friendly pesticides from these plants as botanical insecticides for use as part of an integrated pest management strategy is discussed.

[S1-22] In vitro inhibition of the grey mould fungus - *Botrytis cinerea* by Phaseolinone and Phomenone compounds isolated from *Xylaria* species

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Botrytis cinerea is the cause of grey mould disease and is one of the most destructive plant pathogen species known to man. The fungus causes heavy economic losses of yield in more than 200 crop species among them, vegetables, flowers and fruits. Current chemical control methods used to control the disease include synthetic fungicides, however, the use of these chemicals is restricted due to their carcinogenic effects, acute residual toxicity, long degradation period and serious environmental contamination. In addition, *B. cinerea* has also developed high resistance towards the major classes of commercial anti-botrytis fungicides. This background has actuated the worldwide search for alternative fungicides from naturally occurring compounds that are easily biodegradable and of considerably lower mammalian toxicity. Higher fungi possess versatile secondary metabolism and have been known as prolific producers of a wide range of diverse bioactive secondary metabolites and they continue to be explored through research for crop protection purposes. In this work, as part of the search for naturally occurring bioactive metabolites from basidiomycete strains, crude extracts prepared from 400 strains of ascomycetes and basidiomycetes were screened for activity against *B. cinerea.* The crude extract from *Xylaria* species (JO6049B) showed the highest and reproducible botrycidal activity. Using bioactivity guided chromatographic fractionation method; two botrycidal compounds were isolated and purified from the extracts prepared from fermented cultures of *Xylaria* species (JO6049B). Chemical investigation using 1D and 2D NMR spectroscopic experiments identified the two known eremofilane sesquiterpenoids, phomenone and phaseolinone, which gave minimum inhibitory concentration levels of 34.8 and 33.0 ppm, respectively against *B. cinerea* pathogen.

[S1-23] Potential of crude leaf extracts of *Cupressus lusitanica, Nicotiana tabacum, Azadirachta indica* and *Lantana camara* for control of sweet potato weevil

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In Uganda, sweet potato is a predominant and complementary staple food. The potential to increase sweet potato production is limited by sweet potato weevil, (*Cylas* spp.) causing yield losses of up to 90%. Understanding the effects of botanicals for management of *Cylas* spp. has great potential for an effective and sustainable option. Therefore, this study evaluated botanicals that are effective in the control of weevils where four botanicals *Lantana camara*, *Azadirachta indica, Cupressus lusitanica* and *Nicotiana tabacum* were compared. Field experiments were conducted during 2008 at National Semi-Arid Resources Research institute in Eastern Uganda. Data were collected on vine infestation at 2, 3 and 4 months after planting (MAP) and root infestation at harvest. Results indicated that, plots treated with white Mexican cider and tobacco had significantly less damaged vines and roots compared to Lantana and neem treated plots during plant growth and at harvest. It was also noted that Mexican cider and tobacco reduced the percentage of damaged vines (78%), number and weight of infested roots (97.5%). The use of botanicals on *Cylas* spp. infestation and damage significantly increased storage yields. Nevertheless, further research is necessary to evaluate the effect of botanicals on-farm.

[S1-24] Evaluation of selected crude aqueous botanical extracts against sap-sucking pests in vegetable production

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Cabbage aphid (*Brevicoryne brassicae* L.) is the most problematic pest in smallholder vegetable production, causing 9-77% yield loss in heavy infestations. Current control strategy of using synthetics is widely used but consequently leads to decimation of natural enemies and development of insect resistance. Botanicals have been widely used in smallholder farming but are yet to be rationalized A field trial, laid out in a randomized complete block design, was done to evaluate the efficacy of crude aqueous extracts of *Tephrosia vogelii, Allium sativum* and *Solanum incanum* in controlling cabbage aphids. Fresh leaves of T. *vogelii,* dried *A. sativum* cloves and fresh leaves and fruits of S. *incanum* were pounded using a mortar in their respective quantities, soaked in 1 litre of water for 24 hours, sieved and the filtrate sprayed. Spraying and data collection were done weekly for four weeks. Aphid counts were done 24 hours after application of treatment, on the third leaf from the aerial plant part of two randomly selected plants per treatment and total plant fresh weight per each treatment was determined. Botanicals and dimethoate treatments showed no significant difference ($p>0.05$) on nymph and adult aphid count but both significantly differed from the control treatment ($p<0.05$). There was no significant difference ($p>0.05$) on yield from *T. vogelii* and Dimethoate treatments but both significantly differed ($p<0.05$) with all other treatments. It was concluded that *T. vogelii, S. incanum* and *A. sativum* aqueous crude extracts have some pesticidal effects on cabbage aphid. The three extracts managed to effectively reduce the losses in yield caused by cabbage aphids.

[S1-25] LC/MS-ESI characterization of flavonoids from two food legumes: chickpea (*Cicer arietinum* L.) and mung beans (*Vigna radiata* L.), possible candidates for controlling Striga weed

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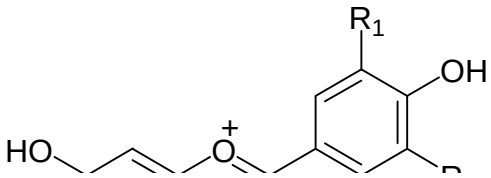
A standardized profiling method based on Reverse Phase-High Performance Liquid Chromatography (RP-HPLC) and Liquid Chromatography coupled with Mass Spectrometry (LC/MS) was used to identify flavonoids in extracts of chickpea (*Cicer arietinum*) and mung bean (*Vigna radiata*), potential trap crops for *Striga* weed. Nine flavonoids including mono- and diglycosyl flavanone and anthocyanidin derivatives luteolin, apigenin, isorhamnetin of pelargonidin, cyanidin, delphinidin, and pentunidin were tentatively identified. The detected phenolics were present at concentrations greater than 0.001% of the dry materials. Many of these phenolics have been reported to have human health benefits. Some of the compounds, including glycosylated flavones are reported for the first time in these two species. The comprehensive analysis of the aqueous secondary metabolites in these leguminous plants is helpful for understanding their traits. Similar traits to *Desmodium uncinatum*, a fodder legume interfering with *Striga* development, could either be exploited or modified genetically to enable the food legumes *C. arietinum* and *V. radiata* attain *Desmodium's* allelopathic ability.



Pelargonidin: R_1: H R_2: H
Cyanidin: R_1: OH R_2: H
Delphinidin: R_1: OH R_2: OH
Pentunidin: R_1: OH R_2: OCH_3

[S1-26] Potent botanical nematicides from the Mediterranean basin

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Sustainable agriculture providing with food quality and sufficiency is a major challenge for farmers, agro-industries, researchers and governments. Synthetic nematicides have long had application in plant protection for the control of the root-knot nematodes (*Meloidogyne* spp.). Phytonematodes represent one of the most damaging pests causing annually more than US$ 100 billion of crop losses in fruit and vegetable production. In the recent years the environmental, food safety and animal welfare issues pose the need for alternative nematode control measures. The screening of naturally occurring compounds in plants, plant secondary metabolites, involved in the complex chemical-mediated interactions between a plant and other organisms in its environment, can provide innovative nematode control measures that can be safely used in Integrated Pest Management (IPM) programs. The Mediterranean basin where various soils and climatic conditions allow a vast plant biodiversity providing botanical chemicals of significant nematicidal potency. Here we report that botanical nematicides extracted from *Melia azedarach, Capparis spinosa, Ailanthus altissima* and *Ruta chalepensis* were greatly effective in controlling root-knot nematodes in vitro and pot experiments. The use of these extracts can potentially provide a valid alternative to the use of synthetic nematicides.

[S1-27] Field efficacy of *Tephrosia vogelii* Hook and *Lantana camara* L. aqueous crude extracts against golden flea beetle, *Aphthona whitfieldi* Bryant, in Jatropha (*Jatropha curcas* L)

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Aqueous extracts of *Lantana camara* and *Tephrosia vogelii* were evaluated against *Aphthona whitfieldi* Bryant in Jatropha curcas L., each at four rates (0.0, 2.5, 5.0 and 10.0% w/v) and a synthetic insecticide, Karate at 2.5 % w/v, in a Randomized Complete Block Design (RCBD) with three replicates per treatment per site. Results showed that, insect pest population, plant damage and chlorophyll content were significantly ($P<0.0001$) influenced by inter-plant, concentration, exposure time, and corresponding factor interaction effects. Irrespective of the plant assayed, concentration, exposure time and site, *T. vogelii* extract was the most efficacious with 29-50% pest reduction at the dosage range tested. Plants treated with *T. vogelii* extract, at increasing dosage, suffered the least damage by *A. whitfieldi* with respect to leaf damage per plant (60-53%), number of feeding holes (21-13) and chlorophyll content (19-22). In the same study, jatropha plants treated with *L. camara* extracts recorded 71-59% leaf damage per plant, 37-22 feeding holes and 17-18 mg/m^3 chlorophyll content. There was significant positive inverse linear relationship ($r = 0.770$) between number of feeding holes and chlorophyll content in which as feeding holes decreased the chlorophyll content increased. The results of this study indicate that *L. camara* and *T. vogelii* extracts hold good potential for control of golden flea beetle.

[S1-28] Phytochemicals of the genus *Aloe* have larvicidal properties against *Aedes aegypti* mosquito

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The current study evaluated the toxicity of fifteen crude plant extracts derived from three species in the genus *Aloe* (*A. ngongensis*, *A. turkanensis* and *A. fibrosa*) against *Aedes aegypti* mosquito (Diptera: Culicidae). A total of fifteen crude extracts of the three plant species (*A. turkanensis*, *A. ngongensis* and *A. fibrosa*) in five organic solvents (hexane, chloroform, ethyl acetate, acetone and methanol) were tested against third instar larvae of *Ae. Aegypti*. However, only nine were active and caused larvicidal effects of about 50% mortality at 2 mg/ml concentration. For *A. turkanensis*, only ethyl acetate extracts caused7 significantly high mortality effects (LC_{50} 0.11, LC_{90} 0.20, LC_{99} 0.33) mg/ml. Similarly, for *Al. ngongensis*, hexane and ethyl acetate extracts had the highest activity of (LC_{50} 0.11, LC_{90} 0.48, LC_{99} 1.67 mg/ml) and (LC_{50} 0.15, LC_{90} 0.32, LC_{99} 0.62 mg/ml) respectively, followed by chloroform (LC_{50} 0.33, LC_{90} 0.62, LC_{99} 1.05) and methanol (LC_{50} 0.39, LC_{90} 0.79, LC_{99} 1.42); while the least activity was with the extracts of acetone (LC_{50} 0.77, LC_{90} 1.57, LC_{99} 2.82). On the other hand acetone extracts of *Aloe fibrosa* were found to be mildly active giving (LC_{50} 0.66, LC_{90} 0.1.76, LC_{99} 3.94) followed by Hexane extracts (LC_{50} 2.39, LC_{90} 5.15, LC_{99} 9.64) and Methanol extracts had the least activity (LC_{50} 3.90, LC_{90} 7.84, LC_{99} 9.56). The observed activities could be an intrinsic value of the plant separate from the solvent of extraction due to their different geographical isolations. These findings are expected to have ramifications on bioprospecting efforts for novel plant pesticidal compounds especially in this genus that is listed under article II of CITES.

[S1-29] Selected insect antifeedants from Kenyan plants with potentials for control of insect crop borers in integrated pest management systems

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Crop losses due to insect pests are colossal in Sub-Saharan Africa, especially in semi-dry and dry land areas where there are poor resource farmers. This is due to high costs, unavailability of appropriate insecticides and application technologies. The major control of insects has been insecticides however due to environmental problems arising from the use of insecticides there is renewed research interests in developing the use of insect antifeedants especially those from plants. Anti-feedants are chemicals which interfere with the initiation and feeding processes but without killing the insects which ultimately may die from starvation. The major stem crop borer species are sorghum shootfly, *Atherigona soccata*; maize and sorghum stem borers, *Chilo patellus*, *C. orichalcociliellus*, *Busseola fusca*, *Eldana saccharina* and *Sesamia calarnistis*; rice stem borer, *Alaliarphase paratella* and cowpea pod borer, *Maruca testulalis*. These insects can cause up-to 80% crop losses in the event of heavy infestation in semi-arid and arid areas in Kenya. In recent years researchers in Kenya have used phytochemical and bioassay guided isolation, purification and structural evaluations leading to the discovery of insect antifeedants from local plants against stem crop borers. However there are no attempts to develop these phytochemicals into products and technologies for the crop protection despite their potentials in their use in integrated pest management system. The following plants have yielded several compounds with moderate to highly active antifeedants; for example, *Tephrosia hildebrandtii*, *Elaeodendron buchananii*, *Tephrosia emoroides*, *Teclea trichocarpa* and *Erythrina latissima*, yielded 6a-hydroxypterocarpan, mutangin, buchaninocide three flavonoids and three alkaloids respectively. Further Kenyan researchers in collaboration with other partners have shown that *Azadirachta indica*, *Ajuga remota* and *Warburgia ugandensis* which grow in Kenya have very potent insect antifeedants in which the following compounds; azadirachtin, ajugarin and warburgia respectively are the most well studied insect antifeedants. This paper discusses results arising from these research efforts including knowledge gaps and suggests the way forward towards the realization of their roles in the control of stem crop borers in integrated pest management system.

[S1-30] Effects of fresh plant derived soil amendments on the management of rootknot nematodes (*Meloidogyne* sp.) in greenhouse tomato (*Lycopersicon esculentum* Mill.) production

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Tomato production is most effective in a controlled environment structure, greenhouse. However, nematode infestation is a major constraint in its production, causing losses ranging between 24 to 38%.Chemical control strategies are some option to large scale farmers in Kenya; however, this compromises environmental safety. This research was carried out to test the potential of two plant derived soil amendments, *Lippia kituensis* Vatke (LK) and *Ocimum gratissimum* L. (OG) to manage root knot nematodes on greenhouse grown tomatoes. The two plants, at flowering stage, were chopped to about 0.5 cm sizes and applied as fresh biomass into the solarized soil as combined and singly at 4 levels, 0% 0 t/ha (0 kg), 2.5% 6 t/ha (0.2 kg), 5% 12 t/ha (0.4 kg) and 10%w/w 24 t/ha (0.8 kg) per pot. The tomato variety Rio Grande was used for efficacy testing. Experimental design was unbalanced factorial experiment embedded in a RCBD with 4 levels replicated 3 times. Negative control was solarized soil with no organic amendment, while, positive control was a recommended rate of commercially known organic based Neem extract (Azadirachtin 0.3w/w). Inoculum density was estimated at 1000 of second instar juveniles (J2) nematodes per plant placed in the root zone. Soil suppressiveness against the root knot nematodes depicted reduced nematode population. A combination of *Lippia* and *Ocimum,* at 24 t/ha, reduced nematodes by 82.4% compared to 92.1% for commercially recommended Azadirachtin against the non-amended soil. There was significant increase in quality and marketable yield, fruit numbers and average fruit weight, as compared to control. Based on the results of this study, *Lippia kituensis* Vatke and *Ocimum gratissimum* L. would be potential sources for nematicidal plant products. Recommended rates for crude products would range from 12 t/ha to 24 t/ha of the two plants combined or double dose used singly for each plant.

[S1-31] Evaluating for host plant resistance against chickpea podborer (*Helicoverpa armigera*) in chickpea (*Cicerinum arietinum*) genotypes using detached leaf assay

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Insect pests are a major constraint limiting chickpea production and among them the most important pest is *Helicoverpa armigera*. Slow progress in developing insect resistant cultivars has been due to difficulties in ensuring adequate insect infestation for screening under field condition. This study was therefore carried out to screen 30 chickpea genotypes using detached bioassay against *Helicoverpa armigera* and identifies resistant genotypes. The study was carried out during the (2009/2010) Rabi season at ICRISAT, India (Patancheru) and modified in Kenya (Koibatek (ATC) during the long rains (2010). Data on leaf area damage rating (HR), larval survival and larval weights, change in leaf weight was used to compare resistance/tolerance with resistant check ICC 506, ICC 37 and susceptible check ICCV 3137. Data was subjected to analysis of variance using GENSTAT release 14.0 statistical package. There was significant variation for Helicoverpa damage rating (Fpr < 0.001), larval survival (Fpr < 0.001), unit larval weight (Fpr < 0.001) and percentage leaf weight change, Fpr <. 001 in a detached leaf bioassay. Genotypes, D039, ICCV 10, ICCV 08311, D012, ICCV 08108, ICCV 00108, ICCV 00305, K036, D055 and D056 showed low host plant damage rating during vegetative stage and flowering, low larval survival percentage (LS%) and low unit larval weight during flowering and vegetative stage compared to resistant check ICC 506 confirming antibiosis as mode of resistance for these Chickpea genotypes. ICCV 08107,D050, K019, K016 and K036 D065, and K025 consistently showed high host plant damage rating , high larval weight, and high percentage larval survival and high leaf weight reduction and could be susceptible to *H. armigera*. A slightly higher host plant damage rating, larval survival, unit larval weight and leaf weight change was observed during vegetative stage as compared to flowering stage showing changes in levels Morpho physio-chemical interactions chemicals such as malic acid with growth stage hence influencing response of the genotypes towards *H. armigera*.

Symposium 2 Postharvest Plenary

[S2-PL] Optimization of pesticidal plants for post-harvest systems

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By far, the most popular use of pesticidal plants by small holder farmers in Africa is for protecting their grain and legumes stored at the household level. Particularly when storing for home consumption, farmers would rather use plant materials instead of synthetics, partly to keep costs down but also because of the perceived dangers of commercial products on their health in comparison to plant materials. The use of pesticidal plant materials for storage protection is relatively easy as often farmers simply layer in leaves or admix powders into the commodity with no further treatment required for a few months. This is generally much simpler and uses much less pesticidal plant material than what is required to repeatedly extract and spray on to field crops throughout the growing season, making postharvest use more sustainable in terms of labour inputs and quantities of harvested wild plant materials. Scientific research on pesticidal plants in Africa has also been strongly focussed on postharvest uses. It's popularity as a scientific endeavour in developing countries is driven by three important factors: 1) Abundant small-holder practice of pesticidal plants for stored product protection does require validation and optimisation; 2) The dramatic divergence of post-harvest issues, technology and research in developed and developing countries means that knowledge transfer opportunities are limited or inappropriate, i.e. Africa is on its own; 3) The relative ease of carrying out postharvest entomological research with limited financial resources or facilities encourages straightforward laboratory evaluations. Over the last three decades, many hundreds of plant materials have been tested against every known stored product insect pest of every durable commodity commonly stored. The great majority of the published literature is focussed on laboratory evaluation and, unfortunately, stops short of evaluating the effects of pesticidal plants in storage under more realistic field conditions and within the conditions found inside small holder farm granaries. I will argue that optimisation and validation of pesticidal plants in stored product protection needs to move beyond the lab and into the field, ensuring issues such as safety for human consumption and phytochemical variability are properly addressed by the scientific community. Examples of NRI's collaborative research actions on the postharvest use of pesticidal plants in Africa will be presented and discussed. Finally, the challenges facing African scientists and institutions to deliver research focussed on the constraints that would increase postharvest use of pesticidal plants will be outlined.

Symposium 2 Postharvest Session talks

[S2-1] Intraspecific variation in the response of *Callosobruchus maculatus* to methyl salicylate, a botanically-derived repellent

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Methyl salicylate is an insecticidal and repellent compound present in plant material from many species, including the pesticidal plant *Securidaca longepedunculata*. To explore its control potential, we used a four-arm olfactometer and tested its volatile repellency effects against individuals of the cowpea weevil, *Callosobruchus maculatus*. We studied a range of individuals of this species of differing ages, sexes and flight morphs in order to discover whether repellency is consistent in all insects. Adults of *C. maculatus* can be flightless (inactive morph) or flight-capable (active morph) and the morphs are known to differ in biology and breeding behaviour. Methyl salicylate was found to repel inactive individuals and females more effectively than males and active individuals, especially at high concentrations. There were also interactive effects between sex, morph and insect age determining the effectiveness of methyl salicylate as a repellent compound. We also analysed the variation in responses of individuals to the odours of host material, and similarly found inter-individual variation in this trait, with inactive individuals most strongly attracted to dry cowpea odours, and females showing a stronger preference for slightly-infested cowpea relative to males. These differences may relate to the differences in biology and life history between morphs and sexes. Our findings highlight that the responses of individual insects need to be taken into account when assaying repellent or attractive odours. Not all individuals of a given species may respond equally and effects of age, sex and, where relevant, morph need to be taken into account to ensure consistent efficacy of control measures.

[S2-2] Chemical composition and insecticidal effect of essential oils of some aromatic plants of Burkina Faso

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The essential oils from leaves or flowers of some aromatic plants, *Blumea oloptera*, *B. aurita*, *Cymbopogon schoenanthus*, *C. giganteus*, *Ocimum basilicum*, *Lippia multiflora*, *Annona senegalensis*, were extracted by hydrodistillation and analysed with GC and GC/MS equipment and then tested on cowpea weevils. Results showed that: *B. oloptera* presented two chemotypes. In the first one, α-pinene (72 %) and limonene (3.5 %) are main components, but the second one has 4-Terpineol (7.4 %), Heptadienal (6.5 %)and α-Pinene (5.9 %) as major components, B. aurita contains α-Cadinol (30 %), δ-Cadine (12.3 %) as major components, C. schoenanthus shows a large amount of Piperitone (57 %) a 2-Carene (18%), C. giganteus oil contain Trans-p-mentha-2,8-dien-1-ol (14,2 %) and Cis-p-mentha-1 (7), 8-dien-2-ol (17 %), *O. basilicum* contains a large amount of Linalool (60 %) and 18 % of Eugenol, p-Cymene (26 %) and Thymol-thymyle acetate (42 %) are the main constituents of *L. multiflora* oils. Essentials oils of *A. senegalensis* contain α-Amorphene (14, 7 %) and α-Cedrene (13 %). Preliminary insecticidal tests against *Callosobruchus maculatus* showed a strong insecticidal effect of the oils extracted from *O. basilicum*, *L. multiflora*, *C. schoenanthus* and *C. giganteus*.

[S2-3] Utilization of *Vernonia glabra* in control of food spoilage, food poisoning pathogens in Kenya

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Food poisoning cause health issues in humans and animals due to ingested toxins produced in food and feed stuffs, hence posing a great threat to food security and food safety worldwide. Even though synthetic pesticides are efficient in the control of pathogens, the same cannot be applied to foodstuff because of safety. Proposed study was aimed at investigating the antimicrobial activity of *Vernonia glabra*, a plant used by herbalists in Kenya for the treatment of gastrointestinal problems and snake bites. Organic and aqueous extracts were screened against *Staphylococcus aureus*, *Escherichia coli*, and *Aspergillus niger*. Minimum inhibitory concentrations (MICs) for active extracts were done using disc diffusion technique. Organic extracts of leaves and flowers showed the highest activity against *S. aureus* (mean inhibition zones (MIZs) of 1.85 and 1.78 respectively), than the standard antibiotic (Streptomycin 1.30). The organic extract of flowers showed significant activity against *S. aureus* at very low concentration of 1.5625 mg/ 100µl, compared to Streptomycin with MIC of 6.25 mg/ 100 µl. Organic extract of leaves showed moderate activity against *A. niger*, inhibition zone of 1.43, a little higher than the standard antibiotic (Nystatin MIZ of 0.83). The results of this study justify the use of *V. glabra* in traditional herbal medicine, and suggest that the plant has ideal characteristics in the application as a bio-pesticide, to control food spoilage and poisoning pathogens.

[S2-4] Effects of various plant extracts on cow pea weevil

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The cowpea weevil, *Callosobruchus maculatus*, is a devastating storage pest of cowpea, Vigna unguiculata. Conventional methods of managing the pest are dominated by use of insecticidal grain protectants, which are expensive. Exploitation of the toxicological properties of plants has not been fully explored to the benefit of the smallholder farmers in Zimbabwe. This prompted the investigation. An experiment which sought to investigate the effects of *Capsicum frutescens* (Red pepper), *Lippia javanica* (Fever tea), *Eucalyptus grandis* (Flooded gum), *Colophospermum mopane* (mopane), *Bauhinia thoningii* (Musekesa) and *Szyzgium aromaticum* (Clove) extracts on cowpea weevils was laid out as a completely randomised design. The results indicate that all the plant material extracts led to at least 95 % mortality. *S. aromaticum* and Actellic Super dust (ASD) had the best results. The results indicate the presence of pesticidal and larvicidal properties in the plant extracts and the potential of the studied plants to prevent cowpea damage and weevil hatching was high. Therefore all the studied plants have the potential to control cowpea weevils although *S. aromaticum* showed the best results that equalled ASD in terms of percent mortality and timeliness of control.

[S2-5] Insecticidal characteristics of *Maerua edulis* (De Wolf) against *Sitophilus zeamais* Motschulsky in stored maize grain: Repellency, toxicity, oviposition deterrence and fumigation potential

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The maize weevil *Sitophilus zeamais* Motschulsky remains one of the most ubiquitous and damaging insect pests of stored maize in SSA and requires cost effective control. *Maerua edulis*, a locally available pesticidal plant prioritized as a grain protectant by smallholder farmers in Zimbabwe was evaluated singly for its repellency, toxicity, oviposition deterrence and fumigation potential, and its effects on progeny development against *S. zeamais*. The powders of *M. edulis* at application rates of 0, 0.5, 1, 2, 4, 6, 8 and 10% *w/w* were tested for their repellency and toxicity and the results revealed the plant having exhibited moderate repellency action against *S. zeamais*. *M. edulis* at 8%*w/w* gave the highest repellency of 61% within 4 hr while the 4% *w/w* gave 57% in 24 hr. In toxicity studies, the plant exhibited high mortality of over 80% at all the application rates and there were no significant differences when compared with Actellic Super Gold (ASG) a synthetic chemical pesticide ($P>0.05$). *M. edulis* significantly controlled F1 emergence when compared to the untreated control *($P<0.05$)*. *M. edulis* also manifested anti-ovipositional action against the *S. zeamais*. There was no significant difference between *M. edulis* and ASG ($P>0.05$) as all the examined kernels had a mean of 2 larval holes in a whole 50g sample. Only F1 insects emerged from the 2%*w/w* and control treatments with a developmental period of 27±5 days and 22±2 days, respectively. All the treatments showed low fumigant potential of ≤ 30% mortality in a 21-day exposure period. *M. edulis* is an effective and cheap grain protectant option for resource-poor farmers and results suggest that it uses a synergy of insecticidal properties to protect grain against *S. zeamais*. The results are discussed in the context of sustainable use of the pesticidal plant by smallholder farmers.

[S2-6] Laboratory evaluation of garlic (*Allium sativum L.*) Liliaceae bulb extracts as protectants against the maize weevil, *Sitophilus zeamais* (Motsch.) Coleoptera: Curculionidae

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Fresh extracts of *Allium sativum* (L.), containing the antimicrobial allicin, were evaluated as possible grain protectant against the maize weevil, *Sitophilus zeamais* (Motsch.) in the laboratory. The studies were conducted in Crop Science Laboratory, Michael Okpara University of Agriculture Umudike Nigeria and Plant Physiology Laboratory, RWTH Aachen University Germany. Each experiment was set out in completely randomized design with four replications and a control treatment. Adult mortality and percentage weight loss were investigated. There was an observed increase in adult mortality following days of exposure in all treatments. Significantly ($P<0.05$) reduced grain loss was also observed in all the treatments when compared with the control. *A. sativum* extracts from Nigeria (GUN) were more lethal (causing 93% adult mortality), when applied topically on the freshly emerged *S. zeamais* adults, compared to the extracts from Germany, GAG. High-Performance Liquid Chromatography (HPLC) analysis result indicated that the amount of allicin in the garlic juice was 1883.2µg/ml. This study highlights the potential of *A. sativum* containing allicin for biorational control of maize grains against *S. zeamais* infestation and damage.

[S2-7] Evaluation of ethanol plant extracts for protection of *Cola nitida* against kola weevils (*Balanogastris* kolae and *Sophrorhinus* spp.) (Coleoptera: Curculionidae) in storage

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The kola weevils *Balanogastris kolae* and *Sophrorhinus* spp. are the most destructive of all kola pests. Study was initiated to evaluate the protective properties of ethanol extracts of 5 plant materials each at 1x103, 2.5x103, 5x103 and 1x104 ppm, against the weevils on stored kolanuts. Parameters assessed were emergence of adult weevils, number of weevil exit holes on the kolanuts and the number of kolanuts with colour change in each treatment. The mean number of adult *B. kolae* emergence from the various extract treatments did not differ significantly from each other. None of the extract treatments compared effectively with the standard treatment (1.38 ± 0.25). A similar trend was observed for *Sophorhinus* spp., but emergence of adult weevils was extremely low (0.03 ± 0.13 to 0.34 ± 0.10). There was no significance difference in the mean number of weevil exit holes recorded for all the extracts at 2.5x103, 5x103 and 1x104 ppm treatment levels except control. Mean number of kolanuts with colour changes recorded for the standard treatment (2.28 ± 0.18) differed only from the various treatment means of *Cederela odorata* (6.16 ± 0.39; 5.81 ± 0.38; 5.28 ± 0.30; 4.97 ± 0.16). Generally, there was no significant difference amongst the various extract treatments means. Extracts therefore could be could be recommended as alternatives to synthetic pesticides as protectants of kolanuts in storage.

[S2-8] Management of cowpea weevil (*Callosobruchus maculatus F*.) in stored cowpea (*Vigna unguiculatus L*.) grains using wild basil (*Ocimum americanum* L.)

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Callosobruchus maculatus is a primary pest of cowpea and other legumes worldwide, both in the field and in stored seeds. *Ocimum americanum* a plant with known insecticidal properties, is used by farmers to protect stored grain against insect attack. A laboratory experiment was conducted to investigate the effect of different parts of *O. americanum* namely; leaf powder, flower, leaf powder and whole plant powder; while a synthetic insecticide, pirimiphos-methyl dust (Actellic) was used as control. Test plant powders at rates of 0.5, 1.0, 2.0, 4.0 and 8.0 g of dried leaf, flower and whole plant were compared for their effectiveness against *C. maculatus* in stored cowpea seed. The percentage mortality after three days was very significant in leaf powder causing up to 92.5% mortality at 8 g/10 g cowpea seed. After 90 days there were clear differences in progeny emergence when the different treatments were compared. Progeny emergence varied from 14 to 107 depending on the treatments with leaf powder, at a treatment of 8g/10g of seed the means were 14, 52.7 and 73.2 for leaf, flower and whole plant treatment, respectively. Results from this study indicate that wild *O. americanum*, leaf powder at the rate of 8 g/10 g cowpea seeds is effective in cutting down weight losses in stored cowpeas. Treatment of grain with basil powders has control implications for *C. maculatus*.

[S2-9] *Calpurnia aurea* essential oil and its components as repellents against maize weevil S*itophilus zeamais*

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Plants volatiles have been shown to exhibit bioactivity against insect pest. The aim of study was to evaluate the repellent activity of the crude essential oil of leaves of *C. aurea* against *S. zeamais* and to identified components present in the leaves of *C. aurea*. Essential oil was extracted from the fresh leaves of *C. aurea* through hydro-distillation, using a Clevenger type apparatus and. The individual components of the essential oils were identified through GC, GC-MS and GC-FID co injection with the authentic standards. The repellent activity of the essential oil was also evaluated by a choice bioassay using a Y- shaped olfactometer. The data obtained was analysed using statistical analysis system (SAS).The major components identified include: Alpha pinene 0.5%, Linalool 2.9%, Limonene 1.3%, Eucalyptol 1.4%, Terpinen-4-ol, 0.4%, Beta ionone 3.7%, p-Cymenol 0.7% and Phytol 4.6%. Results show that the crude oil has good repellent activity and therefore the oil may be used for a repellent formulation.

[S2-10]Field evaluation of pesticidal plants for management of storage insect pests of dried maize and beans in northern Malawi

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Storage losses caused by insect pests are a major food security threat in Africa where grains and pulses are stored for up to 12 months. Pesticidal plants offer a low-cost and environmentally benign alternative to synthetic products for resource-poor farmers. In this study, *Securidaca longepedunculata* root bark, *Azadirachta indica* seed kernels, and leaf powder of *Tephrosia vogelii, Tithonia diversifolia, Vernonia amygdalina* and *Lippia javanica* were evaluated against insect pests of stored maize and bean. Storage trials were conducted on farms in Malawi using each plant material separately. The materials were admixed with maize grain or bean seed at 2 % w/w separately and stored in sacks. Grain damage, weight loss, and number of insects were recorded monthly. After 7 months, untreated maize grain sustained over 90% damage compared to 16 % on maize treated with *A. indica* and *S. longepedunculata*. The lowest grain weight loss was observed in maize treated with S. longepedunculata (1.7 %) compared with untreated maize (14.6 %). After 5 months, the number of adult *S. zeamais* in the *S. longepedunculata* treatment was 162/kg grain compared to 384/kg grain in the *A. indica* treatment and 2,531/kg grain in the untreated control. Similarly, over 75% of untreated beans were damaged, mainly by Acanthoscelides obtectus, compared to only 3% in beans treated with *A. indica* seed kernel which compared favourably with the commercial standard Actellic Super dust. The results suggest that *S. longepedunculata* root bark and *A. indica* seed kernel powders could be used as an alternative to commercial formulations of insecticides for the management of insect pests in stored maize and beans. Practical implications of using the pesticidal plants are discussed.

[S2-11] Assessing the effectiveness of botanical extracts from garlic and neem on controlling of potato soft rot pathogens

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Soft rot of potatoes caused by *Pectobacterium* and *Dickey* a sub-species leads to economic losses in agriculture worldwide including Zimbabwe, where the economic losses range from 20 – 60%. The aim of the present study was to evaluate efficacy of botanical plant extracts in controlling soft rot pathogens. A laboratory experiment was carried out using potato tuber maceration test to screen the effect of two botanicals extract: neem (*Azadirachta indica*) leaf and garlic (*Allium sativum*) cloves in controlling of soft rot disease caused by bacterial pathogens, namely *Pectobacterium carotovorum* subsp. Carotovorum (Pcc), *P. atrosepticum* (Pa) and *Dickey adadantii* (Dd). Preparations of two concentrations (10 and 25% (w/v) of the aqueous extracts of garlic and neem plants were selected and used in dip and spray applications. Sterile distilled water was used as a negative control. Three tuber halves were used for each treatment. Five filter paper discs (Whatman's No. 1) pre-soaked in1 x 10^6 cfu/ml bacterial cell suspensions of Pcc, Pa and Dd respectively were placed on each tuber half and incubated for 48 h at 25°C. After 48 h the filter paper discs were removed and the rotting zone diameter was measured. The experiment was a 3 x 2 x 2 + 1 factorial laid out in a completely randomised design, each treatment replicated three times. Botanicals significantly reduced the maceration effect of the bacteria ($P<0.01$).There were some significant interactions for bacteria x botanical x concentration and bacteria x botanical x method ($P< 0.01$). Method of application and concentration had no significant effect on the rotting zone diameters. The botanicals were effective in reducing the maceration effect of Pa and Dd but did not provide control against Pcc. Botanicals are recommended to be used for controlling soft rots caused by Pa and Dd.

[S2-12] Biocontrol of common grain storage insect pests by use of *Hyptis spicigera*

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Food situation has remained insecure and unpredictable in sub-Saharan Africa, leading to high levels of cyclic famine and poverty. This has been exacerbated by perennial pest problems, which cause substantial pre- and post-harvest food grain losses. Common insect pests such as grain weevils, threaten storage of grains especially in subsistence agriculture, which relies on traditional grain storage facilities. It is against this background that this study was designed to document and scientifically validate the existing indigenous knowledge on insect pest control practices, and generate effective biological control options compatible with the prevailing farmers' circumstances. Similarly, laboratory bioassay on insecticidal potency of *Hyptis spicigera* on grain weevils established that both whole plant parts and steam-distilled non-polar essential oil extracts possess strong insect repellent / fumigant activity at reasonably low doses.

[S2-13] Bio-insecticide formulations with four organic flours as carriers in management of cowpea bruchids *Callosobruchus maculatus* Fabricius (Coleoptera: Bruchidae) in stored cowpea grains

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The increased health and environmental hazards, social concerns and frequent deaths associated with the use of synthetic pesticides in stored cowpeas culminated in the ban in Nigeria. The demand for pesticide-free food necessitates the development of integrated strategies for stored pest management. Study was initiated to apply standard operational procedures to produce safe and affordable technologies that will reduce postharvest losses of grains and thereby raise the livelihood of small scale farmers as well as reduce the drudgery in plant pesticide production. *Dennettia tripetala* Baker f. seeds and *Piper guineense* Schum & Thonn fruit powders were formulated using (*Ipomea batatas* L.), (*Dioscoera rotundata* L.), (*Manihot esculenta* L.) or (*Colocasia esculenta* L.) flour as organic carrier of formulations of 20-100% active material as protectants of Ife brown cowpea seeds against *Callosobruchus maculatus* Fab. *D. tripeala* and *P. guineense* formulated with each carrier at 0.8% caused 100% mortality of adults of *C. maculatus* in 72h, suppressed oviposition and F_1 progeny 60 days post-treatment compared to 0% mortality and 100% seed damage recorded in the untreated control. The formulated *D. tripeala* and *P. guineense* dusts effective against C. maculatus are safe for human and animal consumption while the flours are sources of carbohydrate in diets of Nigerians compared to synthetic insecticides. The formulation may be patented by private enterprise and packaged into ready-to-use form on-shelf by farmers and traders.

[S2-14] *Zanha africana*: a root to protect cowpeas from *Callosobruchus maculatus*

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Powdered root-bark of *Zanha africana* (Sapindaceae) has been used traditionally to protect stored legumes from attack by seed beetles. We report on the compounds that contribute to the anti-insect activity against *Callosobruchus maculatus* (Bruchidae); the bioassays that were used to establish the mode of action of the extracts and the chemical analyses used to characterize some of the compounds contained within the extracts. Sequential extracts were prepared in hexane, chloroform, methanol and water and tested in both contact toxicity bioassays and oviposition bioassays. Mortality of adults was greater in contact-toxicity tests than when extracts were adsorbed onto beans. All extracts caused reduced oviposition by mated females. HPLC coupled to mass spectrometry was used to isolate compounds and NMR analysis of these indicated that the roots contained terpenoids (hopanes), while the methanol and water extracts are rich in saponins, two groups of compounds with reported insecticidal effects. Optimised extraction of *Z. africana* root-bark could result in extracts with maximal efficacy against pests of legume seeds.

[S2-15] Efficacy of selected botanical insecticides reduced postharvest losses of common beans by bruchid species in farm households

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Six pesticide plant products reported by farmers from various bean producing regions were collected in Tanzania and used to evaluate for their ability to control bruchid infestation in stored beans. Crude products were prepared by grinding into fine powders of each of the barks and roots from plant species: *Zanha africana* (Mjui Magome), *Neorautanenia mitis* (Tupadaka), *Z. africana* (Livanga roots Njombe), Actellic Super Dust, *Z. africana* (Mjui roots Morogoro), *N. mitis* (Lidupala), *Schinus molle* (Mpilipili) and *Chenopodium ambrosioides* (Ikanganyishe). Field and laboratory experiments were conducted in different farmers' households and at Sokoine University seed laboratory. Bean samples of 1kg were thoroughly mixed with crude extracts at a dosage of 500g/100kg of bean seeds. Furthermore, a preparation of various combinations with three botanical mixtures from each of the six plant species was tested to determine the best combination for use. *Z. africana* (Livanga roots njombe), *Z. africana* (Mjui Roots Morogoro), and *N. mitis* (Lidupala) provided higher inhibition in bruchid emergence. On the other hand, *Chenopodium ambrosioides* (Ikanganyishe) demonstrated high mortality of insects when tested under laboratory conditions but was not effective under household bruchid trials. This work has demonstrated botanical pesticides as alternative products with comparative efficacy to Actellic super dust a commercial product used for storage pest management.

[S2-16] Evaluation of repellent effects of oils from selected *Eucalyptus* species against *Sitophilus zeamais* (Motschulsky)

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The damage of grain due to storage pests in Kenya lead to quantitative and qualitative losses. Maize is the most important food crop in Kenya and the dominant pest of maize is *Sitophilus zeamais*. Current study undertakes to identify botanical pesticides for control of maize weevils. The essential oils of *Eucalyptus* were extracted by steam distillation using a Clevenger-type apparatus from the fresh leaves of *Eucalyptus saligna, E. globulus, E. camaldulensis* and *E. citriodora*. A repellency bioassay of the oils with varying concentrations was carried out against maize weevils out using a Y-shaped olfactometer. Repeated measures of analysis of variance were applied so as to test the different doses), different repellents and their interactions (dose*repel) on the response variable (percent repellence). The oils of E. saligna and E. globulus were found to be moderately repellent while those of *E. camaldulensis* and *E. citriodora* significantly repellent. Gas chromatography – mass spectrometry (GC-MS) and GC co-injections with authentic samples showed the presence of the following major constituents: 1, 8-Cineole, α-Pinene, β-Pinene, Limonene, Linalool and β-Myrcene. The results provide a scientific rationale for the use of *Eucalyptus* oils in protection of maize against weevils.

[S2-17] Residual bioactivity of *Ocimum americium* L. and *Tephrosia vogelii* Hook. f. essential oils against coleopteran pests and inhibition of wheat seed germination

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Grain pests remain a major threat to food and nutrition security and livelihoods in smallholder agriculture. Although effective synthetic pesticides are available, they are largely incompatible with existing farmer circumstances. In a search for eco-friendly alternatives to synthetic pesticides in grain storage, selected *Ocimum americanum* and *Tephrosia vogelii* essential oils, at five rates (0.0, 0.5, 1.0, 1.5 and 2.0 µL/g grain), were evaluated under semi-hermetic conditions for residual contact toxicity and reproduction inhibition against four coleopteran pests and phytotoxicity on wheat seed germination over a 4-month grain storage period. GC-MS analysis showed *O. americanum* and *T. vogelii* essential oils were eugenol (49.2%) and germacrene D (19.2%) chemotypes, respectively. Results showed strong dose-, contact time- and storage duration-dependent residual bioactivity and germination inhibitions. At 2.0 µL/g grain and 90-120 d, *O. americanum* and *T. vogelii* fruit oils caused 14-22 and 3-47% kill, respectively, of adult *Sitophilus oryzae, Rhyzopertha dominica*, and *Tribolium castaneum*. Similarly, the leaf oils, respectively achieved 58-75 and 37-53% kill of *Callosobruchus chinensis*. At the dose range tested, the essential oils reduced adult F_1 progeny by 28-40%. At 2.0 µL/g grain and 120 d, *O. americanum* and *T. vogelii* fruit oils reduced the wheat seed germination by 25-40 and 33-51%, respectively. These results are discussed in the context of their relevance as grain protectants and implications for the informal seed industry.

[S2-18] Evaluation of effectiveness of selected botanical extracts in managing bean bruchids

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Bean bruchids, *Acanthoscelides obtectus* (Say) and *Zabrotes subfasciatus* (Boheman) are the main storage pests of beans in Africa. Farmers in Tanzania have been using different pesticidal plants which were not uniform from different locations for many years to reduce damage in their produce. Laboratory studies were carried out to investigate the effectiveness of nine botanical extracts in controlling the two bruchid species. The study included plant species from Iringa, Kilimanjaro, Mbeya and Morogoro Regions. The insecticidal materials were extracted from *Eucalyptus citriodora, Vernonia amygdalina, Telfairia pedata, Chenopodium ambrosioides, Neorautanenia mitis, Dolichos kilimandscharicus, Gnidia kraussiana, Zanha africana* and *Schinus molle*. Powders of these plants were tested under the laboratory conditions, where doses commonly used by farmers were tested to identify plant species with superior characteristics. The experiment was set in a completely randomised design to determine the optimum doses of five selected pesticidal plant formulations that can be recommended for protecting beans against bruchids. The effectiveness of the extracts were compared with Actellic Super Dust, a synthetic chemical commonly used for control of bean bruchids. The results show that, all plant species were potential in controlling *A. obtectus*. Two plant species namely *N. mitis* and *C. ambrosioides*, performed similar to synthetic Actellic Super Dust followed by *Z. africana* at 600g/100kg to *A. obtectus* and *Z. subfasciatus*. Out of nine plant formulations evaluated on *Z.* subfasciatus only three were statistically different in their effectiveness compared to untreated beans. The study shows that *C. ambrosioides* and *N. mitis* have higher efficacy comparable to Actellic Super Dust followed by *Z. africana*. Hence, the plants can be used efficiently as the recommended insecticidal plants. However, further study is recommended to assess the insecticidal plants role in seed deterioration during storage, shelf life, pesticidal plant combination and toxicity to mammals.

[S2-19] Ability of neem deed powder and NeemPro to protect stored bambara groundnut against the infestation of *Callosobruchus maculatus* F. (Coleoptera: Bruchidae) in the Adamawa region of Cameroon

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The cowpea weevil, *Callosobruchus maculatus*, is a serious pest of several pulses including Bambara groundnut, *Vigna subterranea*. The predominant control method for *C. maculatus* in pulses is the use of synthetic residual pesticides, which are environmentally unfriendly. The use of plant based insecticides for controlling storage pests constitute an attractive alternative to residual synthetic products, since plant products may be more biodegradable. A commercial neem product, NeemPro and local neem seed powder (NSP) were tested together with the synthetic reference insecticide, Malagrain (Malathion 5% [AI]) for their ability to protect Bambara groundnut against the infestation of *C. maculatus*, regarding adult mortality as well as F1 progeny and larval inhibition. Malagrain at the recommended rate of 0.5 g/kg and the neem products at four rates (0.75, 1.5, 3 and 6 g/kg for Neempro and 5, 10, 20 and 40 g/kg for NSP) were admixed separately with Bambara groundnut seeds. Adult mortality was recorded 1, 3, 4 and 6 days after treatment. *C. maculatus* adults were more susceptible to NeemPro than NSP. Whereas Malagrain caused 100% mortality to *C. maculatus* within 1 day post-treatment, NeemPro caused 68.75% and 98.75% adult mortality respectively within 1 and 6 days, and the NSP induced respectively 30.75% and 66.56% adult mortality within the same time points. 6 d-LC_{50} were 0.001 g/kg for NeemPro and 16.2 g/kg for NSP. The reference insecticide completely inhibited F1 progeny production, which was comparable to the inhibition caused by NeemPro at 3 g/kg and Neem seed powder at 10 g/kg. It could be proposed that NeemPro is a good candidate insecticide for bruchid control in stored pulses. However, in the subsistence farming system in sub-Saharan Africa, where the neem plant is widely available, NSP could be of value in stored product protection involving bambara groundnut and *C. maculatus*.

[S2-20] Effectiveness of botanicals against *Callosobruchus maculatus*, the main pest of stored cowpeas in Burkina Faso

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Cowpea is an essential food legume in the tropics and particularly for sub-Saharan African populations. Postharvest grain storage, however, is a major constraint for crop expansion and year-round availability due to the cowpea weevil, *Callosobruchus maculatus* F. (Coleoptera: Chrysomelidae, Bruchinae), the main storage pest of cowpeas in West Africa. In Burkina Faso, several scientific investigations have focused on the control of *C. maculatus* by botanicals during the past ten years. The studies demonstrated that several plants and/or their extracts were active against eggs, larvae and adults of *C. maculatus*, through dose-dependent mortality responses. Essential oils (EO) extracted from native aromatic plants have yielded the most promising results, some of them being very toxic to bruchid adults (LC_{50} <0.3µl/l for *Ocimum americanum* EO). Other potentially interesting EO tested included *Hyptis suaveolens*, *H. spicigera* and *Lippia multiflora*. Attempts to optimize the use of EO for cowpea storage carried out in lab and field conditions showed that stock size and storage devices influence essential oil effectiveness, in relation to the EO chemical composition. Essential oil from *O. americanum* used as contact insecticide in form of aromatized powders was effective on *C. maculatus* adults depending on the EO carrier and dose tested. The results reported here are discussed in a view of practical use of botanicals and EO as safe alternatives for IPM in stored cowpeas.

[S2-21] Evaluation of botanicals as maize protectants against maize weevil, *Sitophilus zeamais* Motsch

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The ever increasing world population requires high increase in food production and great assurance of food security. About 35% of crops all over the world are destroyed by insect pests. Postharvest losses in maize due to storage insect pests are estimated to range between 20 to 30% of which 10 to 20% of the weight losses have been by the maize weevil *Sitophilus zeamais* after 3 months storage on the farm. In an attempt to formulate biodegradable and safe insecticides from botanical materials, essential oil extracts of *Tagetes minuta, Chenopodium album, Artemisia absinthium* and *Tarchonanthus comphoratus* were screened for insecticidal properties. Essential oil of succulent stem and leaves of the plants, were obtained by hydrodistillation and analysed by GC and GC-MS. Experiments were conducted (mortality bioassays) in order to assess the insecticidal potency of botanical products. The mortality of essential oil of *T. minuta* and *A. absinthium* against *S. zeamais* were 100% within 24 hours at a dose of 1.0%.Thujone present in essential oil of *A. absinthium* (6.9%), d-limonene (8.1%) and eugenol (0.35%) present in *T. minuta* have been reported to have bioactivity against *S. zeamais*. The germination of the maize seeds was not affected by the treatment with essential oil. The botanicals are therefore promising alternative to the unsafe conventional insecticide for the control of stored-product pest, *S. zeamais*.

[S2-22] Evaluation of the indigenous pesticidal plant *Maerua edulis* (de Wolf) against storage insect pests

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Insect pests cause severe damage to stored commodity resulting in loss in weight, seed availability and nutritive quality of food stuffs. *Maerua edulis*, a locally available pesticidal plant prioritized as a grain protectant by smallholder farmers in Zimbabwe was evaluated in two experiments for efficacy and optimum application rate on *Sitophilus zeamais*, *Prostephanus truncatus* and *Rhyzopertha dominica* in *Zea mays* and *Callosobruchus rhodesianus* in *Vigna unguiculata*. In the first experiment *M. edulis* was prepared into a powder and admixed with grain at 0.5, 1, 2, 4, 6, 8 and 10% w/w and compared to Actellic Super Gold dust at 0.05% (ASG); a commercial synthetic grain protectant, and an untreated control. *M. edulis* effectively controlled *C. rhodesianus* and *S. zeamais* with mortality of ≥80% in all application rates, and there was no significant difference between *M. edulis* and ASG at all application rates ($P<0.05$). Against the insect pests, *P. truncatus* and *R. dominica*, *M. edulis* showed varied response with mortality ≤40% over the 3-week exposure period. *M. edulis* significantly controlled F_1 emergence as compared to the untreated control ($P<0.05$). In pot experiments, *M. edulis* at 0.5 and 1% significantly controlled cowpea damage more than the other application rates ($P<0.05$). Efficacy varied with concentration with *M. edulis* 1% providing the best control among the pesticidal plants and also recorded the least weight loss (15%). There were significant differences ($P<0.05$) in terms of effectiveness between treatments at all concentrations in reducing live insect infestation in cowpeas over the 12-week storage period. In maize, grain damage was <20% (this is a very high rate, only makes sense if you compare with control) for all plant treatments at week 8. *M. edulis* on all grain can be an effective option for resource-poor farmers to protect their grain where bostrichids are not a major problem.

[S2-23] Evaluation of *Mucuna pruriens* (DC) seed as a potential treatment against C*allosobruchus maculatus* (Fab.) in stored *Vigna unguiculata* (Walp.) seeds

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The pesticidal effect of *Mucuna pruriens* (L.) DC. (Fabaceae) was evaluated against *Callosobruchus maculatus* F. (Bruchidae). Plant secondary metabolites such as alkaloids, oils and phenolics are known for their pesticidal properties. This work was carried out to investigate the possible pesticidal effect of *Mucuna pruriens* seed powder when incubated with *Vigna unguiculata* (L.) Walp (Fabaceae) seeds. The antifeedant activity of *Mucuna pruriens* seed powder was determined as 88.35%. *Mucuna pruriens* powder might have caused damages to body systems of the insect by various mechanisms. The seed powder of *Mucuna pruriens* has been found to be effective in causing death of the weevils. The result of this work gave strong evidence that the seed powder of *Mucuna pruriens* has pesticidal properties against *Callosobruchus maculatus*. It may be useful in the conservation/storage of grains and seeds, especially under the subsistent farming system.

[S2-24] Activity of extractives from *Albizia anthelmintica* Brongu. and *Teclea trichocarpa* Engl. as biorational alternatives to control the maize weevil (*Sitophilus zeamais*)

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The organic extractives of two Kenyan plants *Albizia anthelmintica* (Mimosaceae) and *Teclea trichocarpa* (Rutaceae) were evaluated for brine shrimp (*Artemia salina*) lethality and for insecticidal activity against maize weevil (*Sitophilus zeamais* Motchulsky). Hexane extract of the leaves of T. trichocarpa displayed mild brine shrimp toxicity (LD_{50} = 153.2 µg/ml), while the other extracts showed no significant toxicity (LD_{50} > 240 µg/ml). The crude extracts, isolated and thereof blends of isolated compounds were treated to maize seeds and the number of dead and alive maize weevils were counted after seven days of -treatment and compared with synthetic chemical: Actellic Super dust (positive control) and drug free (negative control). Both hexane and dichloromethane extracts of leaves of *T. trichocarpa* exhibited the highest mean percentage adulticidal activity at almost all doses, at 600 and 800 ppm these extracts, respectively, were comparable to the positive control. Due to low toxicity and adulticidal activity of *A. anthelmintica* to maize weevil, thus, it was dropped out from further investigation. Chromatographic separation of the hexane and dichloromethane extracts of *T. trichocarpa* afforded two terpenoids (α-amyrin and 3β–sitosterol) and four alkaloids; melicopicine, arborinine, normelicopicine (acridone alkaloids) and skimmianine (furoquinoline alkaloid). The isolated compounds were less active than the crude extracts, from which they were isolated, with mean percentage adulticidal activity of between 10% and 22% at 0.1% w/w of the compounds against maize weevil while, blends of thereof isolated compounds indicated either antagonism or synergism from pure compounds. The results are discussed with regard to the use of the two plants as suitable and sustainable alternatives to synthetic insecticide in maize grain storage.

[S2-25] The feeding deterrence effect of neem oil on the larger grain borer, *Prostephanus truncatus* (Horn)

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The larger grain borer (LGB), *Prostephanus truncatus* (Horn), has become one of the most important insect pests of stored maize in tropical Africa where it was introduced in the early 1980s. An experiment was conducted to investigate the feeding deterrence effect of neem oil on the LGB larvae and adults. Maize grains were ground using a hammer mill and treated with neem oil at the rates of 0.5, 1, 2, 3, and 4% (v/w). Larvae were sieved out of cultures and sorted according to age and fed on treated flour. The larvae were removed from the flour and their weights determined using an analytical balance after 7 and 14 days. Adult LGB were reared on "cakes" prepared from flour mixed with Mondamin® commercial starch at a ratio of 3:1 and treated with neem oil. Treating the flour with neem oil caused a significant reduction (ANOVA, $P < 0.001$) in larval body weight of first, second and third instar larvae at all dosage levels. The effect of neem oil treated flour on survival of the LGB adults was significant ($P<0.05$) at high dosage levels of 3 and 4% only. The effect of neem oil on the survival of *P. truncatus* on maize grains was significant (ANOVA, $P < 0.001$) at high dosage levels only. The results show that neem oil could be important in checking insect population growth of LGB through feeding deterrence.

[S2-26] Insecticidal activity of essential oils of two Kenyan plants against *Tribolium castaneum* and *Acanthoscelides obtectus*.

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A laboratory study was conducted to evaluate contact and fumigant activity of leaf essential oil of *Cupressus lusitanica* and *Eucalyptus saligna* against adult *T. castaneum* and *A. obtectus*. Bioassays were carried out under controlled temperatures (28±2^{o}C) and relative humidity (65±5%) and laid out in completely randomized design with four replicates. In the instant contact toxicity, test oil was applied at five rates (0, 0.05, 0.10, 0.15 and 0.20 % v/w) on grains in 100 ml glass jars and kept for 24-168hr in control room whereas in space fumigation test, the essential oil was applied at five rates (0, 5, 10, 15 and 20 µl/L air) in a space fumigation chamber. Data on corrected percentage mortality were first homogenized using angular transformations before being subjected to analysis of variance (ANOVA) and LC_{50} values were determined using EPA Probit regression analysis. Results revealed that leaf essential oil had contact toxicity and fumigant properties which were significantly ($P<0.05$) influenced by plant, concentration of essential oil applied, duration of exposure and corresponding factor interactions. C. lusitanica was toxic to test insects causing 78.8(LC_{50}:0.112% v/w) and 100 % (LC_{50}:0.023% v/w) mortalities of *T. castaneum* and *A. obtectus*, respectively at the highest concentration (0.20% v/w) 168 hr post- exposure. E. saligna was also toxic and caused mortality of 24(LC_{50}:0.495% v/w) and 100 % (LC_{50}:0.029% v/w) in *T. castaneum* and *A. obtectus*, respectively at 0.20% v/w 168 hr post-exposure. In space fumigation studies, *C. lusitanica* oil, at 20 µl/L, caused 67 % (LC_{50}: 13.87 µl/L air) and 100% (LC_{50}: 2.44 µl/L) mortality in *T. castaneum* and *A. obtectus*, respectively 168 hr post-fumigation whereas *E. saligna* oil, at 20 µl/L air, caused 80 % (LC_{50}:10.97 µl/L) and 100% (LC50: 2.73 µl/L) mortality in *T. castaneum* and *A. obtectus*, respectively. *C. lusitanica* and *E. saligna* essential oils are promising contact toxicant and fumigant with a possibility of incorporation in stored product insect pest management.

[S2-27] Phytochemical studies of some indigenous plants as grain protectants against *Sitophilus zeamais*

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Maize farming, though successful in some parts of Africa is greatly hampered by the post-harvest handling procedures. Smallholder farmers in developing countries like Kenya use different plant materials to protect stored grains against pest infestation by mixing grains with protectants made up of plant products. Dry ground plant material (of which plants?), were tested for their activity against the maize weevil; *Sitophilus zeamais*; (Coleoptera: Curculionidae). All showed no reasonable protectant ability. Essential oils extracted were analysed by gas chromatography–mass spectrometry (GC–MS) and evaluated for repellent and insecticidal activities against *S. zeamais* using the area preference and contact methods. Most oil components identified by analysing their mass spectra to the NBS library of mass spectra using computer routing were oxygenated monoterpenoids or phenolic compounds and the oils were active in repelling (the insect) at doses between 0.005 and 0.125 ppm. The mean mortality values for *Lippia kituiensis* and *Tanacetum cinerariaefolium* (pyrethrum) were not significantly different after 24 hrs of exposure with an average activity of 79 %. *Chenopodium chenopoides, Ajuga remota* and *Ricinus communis* were not significantly different after 24 and 48 hrs of exposure with a mean of 18 and 20% activity, respectively. The most active oil extracts of plants were those of *Eucalyptus globulus, Rosemarinus officinallis, Lantana camara, Lippia kituiensis, Azadirachta melia* and *Azadirachta indica* with LD_{50} values as 0.609, 0.199, 0.171, 0.220, 0.399 and 0.333, respectively. These oil extracts were reasonably comparable to the already known adulticidal and repellent pesticides such as pyrethrum with its LD_{50} being 0.245. The constituents which may be more responsible for the maize grain protectant ability includes 1,8-cineole, limonene, α–pinene, β-pinene, α-terpineol, terpinen–4-ol, and globulol. This implies that a conclusive research carried out using standard conditions could reveal all the responsible components for such high activities. Blends of plants whose activity is known were made and tested against the maize weevil. A blend of *Eucalyptus globulus* and *Rosemarinus officinallis* at 1.0 % concentration gave a PD and WPI of 3.5 and 7.2, respectively. These values are far much lower than their individual PD and WPI values of 15.3 and 12.3, 25.2 and 21.3, respectively. This therefore gives the impression that blend effects in the bioactivity of plant products may well be the norm to follow. Mortality tests by inert dusts were also carried out. Wood ash, Kaolin and Bentonite showed high activity of up to 70 % at 5 % concentration after 168 hours. Gypsum Whiting dusts were not comparatively active since they only exhibited activities below 40 % even at 10 % concentrations after 168 hours.

[S2-28] Potential for agricultural of C-glycosyl flavonoids from plant origin

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Unlike *O*-glycosylation that is favoured by the higher electronegativity of the oxygen atom, *C*-glycosylation is biochemically a more demanding reaction owing to the lower reactivity of the carbon atom. This reaction is catalysed in plants by a *C*-glycosyltransferase. Flavonoids (Figure) have a significant group of *C*-glycosylated derivatives and they have been reported to demonstrate various biological properties with potential agricultural applications. The unique chemistry of *C*-glycosylflavonoids has attracted plant chemists over the years, and as a result, reports on chemistry and biological significance of these secondary metabolites have increased significantly in recent years. The reported biological properties include nematicidal and insecticidal activities. The large majority of these bioactive compounds are flavones and plant families such as Poaceae, Curcubitaceae and Fabaceae are among the main sources. The talk will provide an overview on the chemistry and biological activity of some plant derived flavonoids *C*-glycosides in agriculture based on authors' intensive literature search.

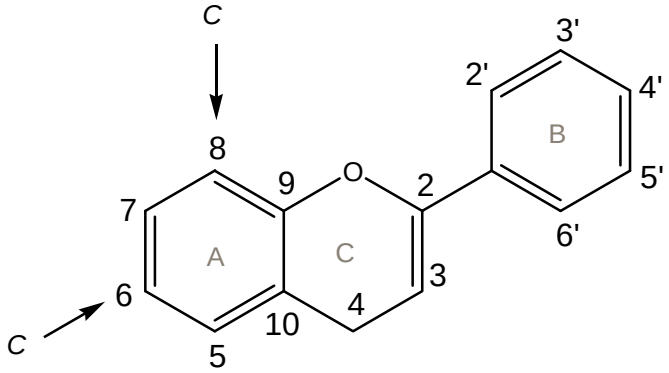

Figure: Generic structure of flavonoids with arrows indicating most common *C*-glycosylation sites

[S2-29] Toxic and repellent properties of *Cupressus lusitanica* and *Eucalyptus saligna* leaf essential oils against *Callosobruchus chinesis* L. and *Sitophilus zeamais* (Motsch.)

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Bioassays were conducted to evaluate the toxic and repellent effects of leaf essential oils of *Cupressus lusitanica,* and *Eucalyptus saligna* against *Callosobruchus chinesis* and *Sitophilus zeamais*. Essential oils from the two tropical plants were evaluated under controlled temperatures (28±2^{o}C) and relative humidity (65±5%) in completely randomized design with four replicates.. For fumigant toxicity, each essential oil, at five rates (0, 5, 10, 15 and 20 µl/L air), was evaluated in 3.4 L space fumigation chambers consisting of suspended metallic cages carrying 20 adult insects and food. Data on number of dead insects recorded 24, 72, 120 and 168 h post fumigation. In contact toxicity each essential oil, at five rates (0.00, 0.05, 0.1, 0.15 and 0.20 % v/w), was applied on 10 or 20g grains in 100-ml glass jars and adult insect mortality recorded 1, 3, 5, 7 and 10 days after treatment. In the choice bioassays similar doses of test essential oil were evaluated in an alternate untreated (control)-treated arrangement and number of insects in the control (N_C) and treated (N_T) grains recorded after 1, 3, 5 and 24 h after exposure and percent repellence (PR) subsequently computed. Results showed that end-point toxicity , and PR of *C. lusitanica,* and *E. saligna* leaf essential oils were significantly (P<0.05) influenced by plant species, concentration of essential oil, duration of exposure and corresponding factor interactions. The *E. saligna* and *C. lusitanica* essential oils, at 10 µl/L air, caused 100% and 85% kill, respectively, against adult *C. chinesis* 168 h post-space fumigation. However, the two plants' oils, at 20 µl/L air, induced a very weak fumigant toxicity of 65% and 67%, respectively against adult *S. zeamais*. In the contact toxicity studies, *E. saligna* and *C. lusitanica* oils, at 0.20% w/w and 168h exposure, caused 62 and 91% mortality of adult *C. chinesis* respectively. Results of choice bioassays showed that *C. lusitanica* and *E. saligna* essential oils had negative PR values against adult *C. chinesis* and hence acted as an attractant. However, the same oils evoked a moderate repellence with highest PR value of 37% for *C. lusitanica* and 27% for *E. saligna* against *S. zeamais*, respectively. These findings have demonstrated the potential botanical pesticides for incorporation in pest management systems in small-holder agriculture.

[S2-30] Can the biofuel crop, *Jatropha curcas*, be used as a locally-grown botanical pesticide? A lab and field study in Zambia

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Jatropha curcas is grown as a biofuel crop in the tropics, and in many parts of Africa it also has a number of domestic uses, e.g. it is frequently grown as a hedge. The collapse of the biofuels market in Zambia has inspired a search for alternative uses for this plant. Previous laboratory studies suggested that Jatropha exhibits a range of beneficial properties, including pesticidal properties. In this paper, we report a series of studies aimed at testing whether formulations of Jatropha powder or oil are effective against storage pests infesting cowpeas and maize. These include laboratory experiments in the UK and field studies conducted with village farmers in Zambia. We report these findings, and discuss the role of participatory research in aiding the adoption of locally-grown botanical pesticides amongst resource-poor farmers in rural Zambia.

Symposium 3 Farming systems, veterinary and general Plenary

[S3-PL] Status of organic agriculture and use of pesticidal plants by organic farmers in Kenya

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The current world food systems are not ideal and are not sustainable evidenced by food insecurity for large populations, inequitable distribution and use patterns of food and externalities in overuse, pollution and destruction of critical resources. Many development initiatives have been fronted as panacea to the situation among them organic agriculture which aims at combining food security, rural development with sustainable use of natural resources and enhancement of ecosystems services. Worldwide, organic agriculture products represent one of the fastest growing food industries. In Kenya the sector has grown from a small informal sector in the 80's to a recognized industry with immense contribution to the GDP of the country. A lot of research has been done on organic agriculture practices including use of plants to control pests and diseases including validation of some farmers' practices on the same. This paper describes the current status of organic agriculture in Kenya and evaluates the use of pesticidal plants by organic farmers in Kenya. It also describes some innovative approaches that have been used by farmers to manage pests and diseases and how smallholder farmers can be empowered to adopt simple appropriate knowledge systems to increase productivity at minimal cost. It concludes with some lessons learnt and the opportunities that African small holder farmers can to take advantage of in the use of pesticidal plants and organic agriculture

Symposium 3 Farming systems, veterinary & general session talks

[S3-1] The poisonous and the sensuous in Chibobo's community lab: Lessons learned from a farmers' led biopesticidal experiment in Zambia

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This paper reflects from a science and technology studies (STS) perspective how to set up participatory experiments to test the efficacy of pesticidal plants. The paper addresses some of the main challenges facing an interdisciplinary team of academics, local farmers and extension officers when designing and implementing a novel and participatory method as part of an ESPA-funded project 'Bridging knowledge systems to alleviate poverty'. The main aim of the project is to develop a new perspective on doing science and to create an expert knowledge system that will help farmers to protect their crops from field and storage pests. Through detailed weekly recorded diaries, a team of natural and social scientists have gained unique insights how farmers observe in nature, how they define efficacy, how they set up experiments and how knowledge is shared and situated in daily village life. Whilst the project is still ongoing, we can tentatively unpack the notion of traditional knowledge and trace the fluidity and networks of knowledge about pesticidal plants in a village ecosystem. This project shows that traditional knowledge is not just a collection of facts or myths that have been passed on from generation to generation but is situated in a complex network of local 'experiments'. In this paper, we trace some of these networks between the bees on the Jatropha curcas flowers, the taste of the honey, the poisonous concoctions of the medicine men and how this string of knowledge eventually gets translated in a village lab that is then connected to the lab at Lancaster University to test J. curcas as a biological pesticide.

[S3-2] Ethnobotanical study on medicinal plant material used to treat and manage diabetes mellitus and other diseases in Phalaborwa, South Africa

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An ethnobotanical survey of plants was conducted in Mashishimale village in Phalaborwa and the aim was to study medicinal plant material used by traditional health practitioners for treatment of diabetes mellitus and other diseases. Traditional health practitioners were identified using the snowballing sampling technique. Structured interviews were conducted and a list of medicinal plants compiled. Data collection included local names of the plants, the plant parts used in the traditional medicine, type of diseases treated by the plant-based remedies and the method of preparation of the medicines. It was discovered that most of the practitioners use stem barks and roots for treatment. About 14 plants species were indicated for treatment of diabetes mellitus, while most plant species were indicated for sexually transmitted diseases, fertility and erectile dysfunction. Scientific investigation is therefore needed to isolate active compounds, understand preparation of infusion and dosages to be taken and to guide the regulation of herbal medicine industry.

[S3-3] Natural botanical larvicides for the control of the malaria vector *Anopheles gambiae*

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Interest in the control of *Anopheles gambiae* lies in the fact that it acts as a vector of malaria. There is no effective vaccine for malaria and therefore, the only efficacious approach of minimizing the incidence of this disease is to eradicate and control mosquito vectors mainly by application of larvicides to larval habitats. The plant-derived natural products as larvicides have the advantage of being harmless to beneficial non-target organisms and environment when compared to synthetic ones. As part of our continued search for natural mosquito larvicides, we assayed the larvicidal activity towards third instar larvae of *A. gambiae* of compounds from *Piper capense, Zanthoxylum lemairei, Z. leprieurii* and an endophytic fungus *Podospora* sp. from *Laggera alata*. The essential oil of P. capense which was dominated by sesquiterpenes (43.9%) showed good larvicidal activity with LC_{50} and LC_{90} values of 34.9 and 85.0 µg/ml, respectively. Alkaloids isolated from *Z. lemairei* showed high potency against the larvae with mortality rates of over 95% at a concentration of 250 µg/ml. Acridone alkaloids isolated from *Z. leprieurii* had high larvicidal activity. The most active one 1-hydroxy-3-methoxy-9-acridone had LC_{50} and LC_{90} values of 39.6 and 77.513 µg/ml, respectively. The xanthone sterigmatocystin isolated from *Podospora* sp. was the most active with an LC_{50} of 13.3 µg/ml.

[S3-4] Potential and uncertainties in utilization of pesticidal plants in pest management among small-scale farmers in Nakuru, Kenya

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The domestication of crops has required farmers to devise ways of managing pests in order to increase yields, improve quality of produce and ensure profitability. After the World War II, the use of synthetic pesticides made impressive impacts on pest control and resulted in pest management becoming synonymous with pesticide use. However, it was not long before the limitations of synthetic pesticides became evident as pest problems persisted and also negative effects on human beings and the environment. A study was conducted in Nakuru to determine pest management practices among vegetable farmers. The objective was to find out the extent to which farmers used alternatives to pesticides in pest management. The farmers acknowledged that less dependence on synthetic pesticides was safe for their health and the environment. The botanical or plant based pesticides were viewed as a cheap alternative of pest management since the materials used were locally available. The major limitation in the use of the botanical methods however was lack of specificity in dosages and methods of application which the farmers said limited their effectiveness in pest management. The farmers reported that although the botanical methods provided protection for their crops it was more of trial and error because they were not sure of the correct dosage and spraying interval. The farmers indicated the need for more research and education on ingredients, dosages, methods of preparation and application and target pests. Pesticidal plants can thus provide a much needed alternative in pest management especially for small-scale farmers. However, if pesticidal plants are to become a viable pest management option for farmers, more research and education on preparation and utilization methods is required to reduce uncertainty about their effectiveness.

[S3-5] The effectiveness of S*phenostylis erecta* in controlling blue tick (*Boophilus decolaratus)* infestation

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The effectiveness of *Sphenostylis erecta* extracts against *Boophilus decolaratus* ticks prevalent in northern Zimbabwe, was investigated. *B. decolaratus* tick larvae, hardened for 8 to 10 days, were exposed to different concentration levels of *S. erecta* extracts in vitro using a 3 X 6 factorial experiment in a *c*ompletely *r*andomised *d*esign. The Soberanes' technique was used and tick larvae were incubated at 27 ^{0}C, 85-90% relative humidity (RH) and photoperiod of 12:12 (Light: Dark). There were three exposure periods of ticks to plant extracts (i.e., 24 hours, 48 hours and 72 hours) and 6 concentration levels of *S. erecta* extracts (i.e., 10 %, 20%, 50 %, 80 % and 100 %). Tick buster (Amitraz), was used as positive control. Each treatment was replicated six times, with 100 tick larvae per replicate. Mortality was used as an indicator of effectiveness of treatments. There was a significant interaction between concentration level and exposure period ($P < 0.05$). The 100 % concentration level of S. erecta extract achieved 98 % mortality, while 10 % concentration level had 0 % mortality within 24 hours. However, as concentration increased from 20 % to 80 %, mortality also increased from 10 % to 70 % within 24 hours. There was over 50 % mortality at concentration levels above 50 % plant extract in 48 hours. At 72 hours of exposure, concentration levels of 20 % and above achieved 100% mortality. Even 10 % concentration level achieved slightly over 50 % mortality at 72 hours. Tick buster had 100 % mortality within 24 hours. The conclusion from this study was that *Sphenostylis erecta* plant extract is acaricidal and is as potent as tickbuster at high concentration within 24 hours. At lower concentration levels, *S. erecta* requires a longer exposure period than 24 hours to be effective against *B. decolaratus* ticks.

[S3-6] Larvicidal efficacy of various local plant extracts against *Aedes albopictus* Skuse (Culicidae: Diptera) in Pakistan

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Globally plants have been reported to contain compounds, exhibit insecticidal and larvicidal properties; especially on the larval stages of mosquitoes. Potential parts of locally grown plants; Seeds of nutmeg (*Myristica fragrans*), peel of musambi (*Citrus sinensis*), leaves of babuna (*Matricaria chamomilla*), Mint (*Mentha spicata*) and ginger rhizome (*Zingiber officinale*) selected and evaluated for their larvicidal properties against *Aedes albopictus*. Oils were extracted through steam distillation process and extracts were evaluated as per WHO guidelines for insecticides against larvae of mosquitoes. Among the five plant extracts; *Citrus sinensis* had the lowest LC_{50} (400.81 ppm) after exposure of 24 hours. While in terms of % age mortality, a series of concentrations (300-800 ppm) gave high % mortality. The result revealed that all the 5 plant species have larvicidal effects to certain extant and *Citrus sinensis* had great potential. Further small scale field trials with the extracts of the most promising ones (*Citrus sinensis*) shall be conducted to determine operational feasibility.

[S3-7] Effects of land ownership on land investment: A case of Central and southern Malawi

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In Malawi growth of agricultural sector is being undermined by continual reduction in crop production plus massive post-harvest losses through poor pest and disease management both in the field and in storage. This threatens food production which is a major income component for the majority of rural households in most parts of Africa. Many authors have indicated that use of pesticidal plant products in controlling pest and diseases of crops both in field and in storage as one traditional way is the most cost effective way. This was however constrained by limited population of pesticidal plants in the local communities. The major question is whether growing of pesticidal plants by rural households in Malawi is being affected by tenure security systems of their plots. In Malawi, there is information gap on the effects of land ownership on land related investments. To understand the issue further, a random effects probit econometric model was used to analyse the factors that are associated with land related investments. Furthermore a random effect to bit econometric model was used to analyse the intensity of investments under a given land tenure security system. The study took place in central and southern part of Malawi. The location of residence (matrilocal and patrilocal residence in matrilineal and patrilineal type of land tenure security system) was used as a proxy for land ownership security system due to lack of legal identification of customary land. The land related investments which were used include use of manure, growth of natural trees and growth of exotic trees (pesticidal plants included). The results of the analysis indicated that there is a weak association between land tenure security and land related investments. The results also indicated no any association between patrilocal residence and manure investment, some correlation between choice of patrilocal residence and natural trees investments and very weak association between choice of patrilocal residence and natural trees investments. Finally it was noted in both central and southern Malawi that land related investments were associated with other factors rather than the land ownership security itself and the investment in question. Hence giving a positive indication that farmer can invest in multiplication of pesticidal plants.

[S3-8] Farmers' knowledge and perceptions on the use of pesticidal plants for rodent control in maize farming system in Tanzania

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A study was conducted in three districts (Handeni in Tanga region, Mvomero and Kilosa in Morogoro region) of Tanzania from May to September 2012 where three villages were selected in each district. The aim of the study was to assess the farmers' knowledge on the use of pesticidal plants for rodent control both in fields and storage. A total of 260 farmers were selected randomly from 9 villages for interview. The maize production constraints and their control measures were assessed through individual interviews using semi structured questionnaires. Farmers (46.5 %) ranked higher the rodent pests than the other pests. The crop loss due to rodents estimated by farmers was 62.1% and 36.9 % in fields and stores, respectively. The most common used rodent control measures were rodenticide (44.1%), snap and wire traps (18.8 %), pitfall trap (15.3 %), digging rodent burrows (10.6 %) and using cat animals (11.2%). Rodenticide use did not differ ($P \geq 0.05$) between districts. However, farmers use rodenticides without full understanding of their effects to environment and health. Only 10.4% of respondents reported that they attained training on how to apply rodenticides. With regard to the use of pesticidal plants 10 % of respondents reported to use them for insect pest control while 1.5 % use for rodent control. The reasons for not applying pesticidal plants for rodent control was that, they were not aware whether there are some plants which can control rodents. It is revealed that farmers in Morogoro and Tanga regions do not have cheap and safe rodent control methods. However, results showed that most of respondents were willing to use pesticidal plants if they are informed that there are plant pesticides capable for rodent control. Therefore, evaluation of indigenous pesticidal plants for rodent control will reduce chemical risks to poor resource farmers.

[S3-9] Evaluation of *in vivo* acaricidal effect of soap containing essential oil of *Chenopodium ambrosioides* leaves in the western highland of Cameroun

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Study on acaricidal properties of foam soap containing essential oil of *Chenopodium ambrosioides* leaves was carried out on *Rhipicephalus lunulatus*. Four doses of essential oil (0,03 ; 0,06 ; 0,09 et 0,12µl/g) and a control with four replications for each treatment were used for in vitro trial. Each replication consisted of 10 ticks in a Petri dish with filter paper impregnated uniformly with the foam soap on the bottom. Following in vitro trials three doses (0,06 ; 0,09 et 0,12µl/g) and the control were selected for *in vivo* test Based on mortality rate recorded from in vitro trial. Each of three replications was made up of 10 goats naturally infested with ticks. Our Results indicate that foam soap containing essential oil of *C. ambrosioides* leaves is toxic to *R. lunulatus*. The in vitro mortality rate was observed vary from 0 to 33.33 % on day 8 after treatment with the control as compared to 79.16 % with the lowest dose (0.03 µl/g) on day 8 and 100% With the highest dose (0.12 µl/g) on day 4. Meanwhile, the in vivo mortality rate was observed to be 22.69 % with the control on day 8 after treatments whereas the highest dose (0.12 µl/g) killed 96.29 % of the ticks within the same period of treatment. LD50 of the foam soap containing essential oil of this plant were 0.037 and 0.059 µl/g on day 2 after treatment, in the laboratory and on the farm respectively. This indicates the potentially high efficiency of this medicated soap on this parasite. In conclusion, the result indicate that the medicated soap containing essential oil of *C. ambrosioides* leaves can be used as antiparasitic agent in the treatment of ticks in infested goats.

[S3-10] Effect of pounded dawadawa (*Parkia biglobosa*) pod husk extract on strongyle in West African Dwarf (WAD) Goats

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A preliminary study was conducted to assess residual effect of Dawadawa (*Parkia biglobosa*) Pod Husk Extract (DPHE) on strongyle ova counts in West African Dwarf (WAD) goats. Eight nanny WAD goats (four per treatment) from Animal Science Department livestock farm at Nyankpala in the Tolon / Kunbungu District of the northern region of Ghana were used. The study lasted for eighteen days between the month of December 2011 and January 2012.DPHE was prepared by pounding and soaking (1kg/1.5litres of water) and mixture was allowed to stand for 12hours. The filtrate (DPHE solution) was administered orally, 0.6ml/kg of body weight (BW) to experimental animals (treatment) as against no DPHE in control. Faecal samples were taken from the experimental animals before administration of DPHE and every three days thereafter up to the 18th day for laboratory analysis of strongyle ova. A two-tail t test was used to analyse the data. Eggs per gram of faeces from animals orally drenched with 0.6ml/kg BW of DPHE showed no significant difference ($P<0.05$) from day 3 to 9 but decreased significantly ($P<0.05$) from day 12 to 18. The dosage of 0.6ml/kg BW of DPHE resulted in 26 % reduction in ova count as against a 13% increase in control with reference to the base counts for the given period of study.

[S3-11] Acaricidal effect of foam soap produced from the essential oil of *Ocimum gratissimum* leaves on ticks (*Rhipicephalus lunulatus*) of West African Dwarf goat

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Study on acaricidal properties of foam soap containing the essential oil of *Ocimum gratissimum* leaves was carried out on *Rhipicephalus lunulatus*. Five doses of oil (0.00; 0.04; 0.06; 0.08 and 0.10µl/g) were used in vitro. Each replication consisted of 10 ticks in a petri dish with filter paper impregnated uniformly with the foam soap. Following in vitro tests, doses 0.06; 0.08 and 0.10µl/g were selected for *in vivo* trial. Each replication was made up of 10 naturally tick infested goats. Our results indicate that foam soap containing essential oil of *O. gratissimum* leaves is toxic to *R. lunulatus*. The in vitro mortality rate was observed to vary from 0 to 30% on day 8 after treatment with the control as compared to 80% with the lowest dose (0.04 µl/g) on day 8 and 100% with the highest dose (0.10 µl/g) on day 3. Meanwhile, the *in vivo* mortality rate was observed to be 22.69% with the control on day 8 after treatments whereas the highest dose killed 93.87% of the ticks after the same period of treatment. LD_{50} of the foam soap containing essential oil of this plant were 0.061 and 0.066 µl/g on day 2 after treatment, in the laboratory and on farm respectively. These results indicate this medicated soap is potentially of high efficiency on this parasite.

[S3-12] Participatory approach to scientifically prove indigenous knowledge of the treatment of animal diseases: Assessing of traditional medicine effectiveness on guinea fowl mortality

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Since 2004, innovative farmers from the East region were supervised by ADELE, a local based project through a process for scientific validation of their expertise and indigenous innovations. In collaboration with the Department of Animal Production of INERA, a system in two stages was conceived with the view to verify scientifically the effectiveness of local remedies for guinea fowl chicks' mortality. The first stage consisted of verification by assessment (obviousness tests) in research station of the prophylactic effects of the remedy on a group of guinea fowl chicks (one day age) divided into three groups: group I (no treatment), group II (remedy of Mr Yonli), group III (type of treatment used by government agencies in extension). The parameter retained to appreciate the effectiveness of the remedy is the rate of mortality of the chicks registered during three months period. The remedy of Mr Yonli has showed the best results. After the first stage, biological, phytochemical and toxicology studies in laboratory were performed on three products of the remedy of Mr Yonli for scientific understanding of their effectiveness and the possible limits of their use. Toxicology studies were done in particular and the DL50. For the phytochemical studies, the extract of chemical components was done with vegetable material by exhaustion using solvent with an increased polarity: dichloromethane (CH2CL2), ethanol (EtOH 95), and water (H2O). The research of chemical constituents with high therapeutic potential which are : alkaloids, flavonoids, anthocyanoside, tannins, saponosides, coumarin, anthracenoside, triterpenes and steroids were done by three complementary methods : (i) the change of colour according to the method described by Ciuli (1) ; (ii) the chromatographic analyses on thin layer according to the method described by S. Bladt (2) ; (iii) the UV- visible spectral analysis done according to the method validated by our laboratory (MEPHARMA).The results obtained on all the toxicology tests show that each product studied is at least of moderate toxicity with Maximal No Dying Doses (DMaNM) per os > 1500 mg/kg (21 days) for the first product TI, > 400mg/kg (21 days) for the second product TII and 100 mg/kg (21 days) for the last one TIII. The results obtained on all phytochemical analyses show that the product TI contained terpenoids. In addition to the presence of sterols and triterpens (terpenoids), the product TII contains also some tannins, coumarinic components and some anthocyanosides in high proportion.

[S3-13] Effect of *Crotalaria falcata* fallow on potato bacterial wilt (BW) incidence, severity and latent infection in tubers field soil

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Potato production in tropical highlands is threatened by bacterial wilt (BW) caused by *Ralstonia solanacearum*, among other constraints. Recent upsurge of BW in highlands may be related to declining soil fertility, short or no fallow period, inappropriate crop rotation, use of low quality seed, seed recycling and possibly global warming-related pathogen adaptation. Technologies aimed at reducing soil-borne *R. solanacearum* are imperative to maintain supply of quality seed for sustained potato production. Thus, field experiments were conducted in BW-infested fields in south western Uganda to test the effect of crop rotation and *Crotalaria falcata* as an improved fallow or green manure to reduce or eliminate soil-borne BW infestation. A one-year *C. falcata* fallow reduced BW incidence by more than 85%. Beans and maize rotation and natural grass fallow reduced BW incidence by 43.9, 37.6 and 27.0% in one year, respectively. More than 50% of harvested tubers in plots continuously planted with potato were visibly infected with BW compared to < 3% of tubers from *C. falcata*-fallowed plots. Apparently healthy tubers from plots previously fallowed with *C. falcata* were free from latent BW infection compared to tubers from maize and beans rotation or one-year natural grass fallow or plots continuously planted with potato. Plots fallowed with *C. falcata* had the highest total and marketable tuber yield compared to other rotation crops used in the study. The residual benefits of *C. falcata* as a fallow on BW incidence, disease severity and latent infection were evident together with improved potato productivity. *Crotalaria falcata* has potential to improve soil health favouring growing of potato in fields previously infested by *R. solanacearum*. However, the mechanism to how this is achieved needs further investigation.

[S3-14] Above-ground competitive and complimentary effects of Artemisia (*Artemisia annua* L.) and maize (*Zea mays* L.) intercropping in a sub-humid ecozone of western Kenya

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An intercropping study at Maseno, western Kenya investigated some above-ground inter-species competitive effects of Artemisia and maize intercropping in two consecutive rain-fed growing seasons between September 2009 and August 2010, by evaluating growth habits and yield patterns from among eight different spacing regimes. The Competitive Ratio (CR) and Replacement Value of Intercropping (RVI) were used in the evaluation of artemisinin, relative chlorophyll content, and biomass yield using 8 treatments (T1,T2,T3,T4,T5,T6,T7,T8) laid out in a randomized complete block (RCBD) design with 3 replications. Cost-Benefit analysis (CBA) was used to evaluate the economic yield potential of the different treatments. Spacing had no significant effect ($P>0.05$) on Chlorophyll content of intercrops, *Artemisia* crown diameters, and plant heights in both seasons. The short rains' treatments had a significant effect on artemisinin yields ($P>0.05$) but lower content of 0.74% than the long rains' season mean of 0.8%; A positive correlation ($r^2=0.7$) between artemisinin sequestration and relative chlorophyll content of Artemisia leaves was observed at harvest. There was a significant effect ($P<0.05$) on CR of *Artemisia* against maize among the intercrops. Unlike maize, there was a significant effect of spacing on RVI ($P<0.05$) for Artemisia. There was completely no usage of pesticides' as no incidence of pests or diseases were observed in the trials except a few insignificant cobs of maize with Head smuts in T7 at harvest. From CBA it is concluded that the presumed weed suppression ability of *Artemisia* effectively reduced the variable cost of production by 35-50%. It is concluded that Artemisia is more competitive than maize when the two crops are grown together in association with optimal spacing, except when the planting pattern is altered to facilitate optimal growth habits. By varying spacing regimes and hence plant densities for variable costs of maize and *Artemisia*, profitable *Artemisia* + maize intercropping may require that farmers apply spatial arrangements in which complementary effects on net output exceed competitive abilities of *Artemisia*.

[S3-15] Optimising the acaricidal efficacy of pesticidal plants used for small-scale tick control

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The study of pesticidal plants continues to progress in Zimbabwe as in other parts of the world focusing on various aspects including: efficacy, toxicity, mode of action, phytochemistry and optimization. We report several optimization strategies that were evaluated including: use of a surfactant; pure plant compounds; mixing different plant materials; hot water extraction; and organic solvent extraction using the plants *Solanum panduriforme, Strychnos spinosa, Lippia javanica* and *Maerua edulis*. The evaluation was on-station against adult ticks and in the laboratory against tick larvae. Mashona cattle at Henderson Research Institute in Zimbabwe were used for the on-station trials in completely randomized design experiments. An adaptation of the Soberanes technique was used in the laboratory bioassays with *Rhipicephalus (Boophilus) decoloratus* species tick larvae. Bioassay results showed that pure compounds of *S. spinosa* and L. javanica were not effective against tick larvae with no larvae mortalities recorded. Mixing *L. javanica* and *S. panduriforme* each at 5% w/v in a 1:1 ratio increased tick larvae mortality significantly ($P<0.05$). The use of hot water and a surfactant reduced tick load of adult ticks significantly compared to cold water and no surfactant treatments on-station and also increased mortality of tick larvae in *L. javanica* and *M. edulis* treatments in bioassay experiments respectively. There was no significant difference between tick larvae mortality of 20 and 25% w/v methanol extracted *M. edulis* and Tickbuster®. These results suggest that acaricidal activity can be increased using fairly easy and low-cost methods such as hot water and addition of a surfactant for extraction, and mixing of compatible plant extracts. Isolated pure compounds were not effective suggesting missing possible synergistic effects derived from using different compounds to induce acaricidal activity. While methanol is an excellent solvent, its use is limited by availability to resource-poor farmers.

[S3-16] Chemical composition of essential oil of *Solanum sarrachoides* and its bioactivity against *Tetranychus evansi* Baker & Pritchard (Acari: Tetranychidae)

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African nightshades (*Solanum* spp.) are among the top priority African indigenous vegetables (AIVs) grown and consumed by low-income rural, urban and peri-urban households in East Africa. *Solanum sarrachoides* Sendter is among the commonly grown African nightshades in East Africa although it is a less preferred type due to its hairy leaves. Although African nightshades are alleged to be tolerant to pests and diseases, a recent study showed how differences in morphological and volatile chemical factors among them influence the population growth of the tomato spider mite *Tetranychus evansi* Baker and Pritchard. *T. evansi* is considered as one of the most destructive spider mite species in solanaceous crops such as African nightshade. The study showed that *S. sarrachoides* consistently did not support *T. evansi*'s intrinsic rate of increase. We hypothesized that these differences were not only antixenotic, but possibly due to presence of chemical factors within the plants evident trichomes. Constitutive defence in *S. sarrachoides* forms the basis of our research in order to explore its potential for biopesticide use against *T. evansi* and other arthropod pests. Chemical composition of essential oils in *S. sarrachoides* and its biological activity against *T. evansi* were determined. Essential oils from fresh leaves and berries of S. sarrachoides were obtained by hydrodistillation and analysed by gas chromatography-mass spectrometry (GC-MS). The major constituents were monoterpenes which were higher in the leaves than berries. The essential oils and their major chemical constituents were screened for oviposition deterrence activity against *T. evansi* and compared with two positive controls. Dose response studies suggest that essential oils of *S. sarrachoides* demonstrate acaricidal activity by deterring oviposition of *T. evansi*. This response also depends on the abundant chemical constituent present. Therefore these African nightshades, having bioactive functional components against *T. evansi*, can be used as excellent materials for biopesticides.

[S3-17] Effect of *Annona* formulations on non-target invertebrates and on physicochemical water parameters at semi-field condition

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Laboratory studies reveal that plant species from family Annonaceae particularly the genus *Annona* have bio-pesticidal properties that offer alternative to synthetic ones. However information about their efficacy in the natural environment is scant. Evaluation of botanical larvicides formulation from Annona in laboratory and natural environment is of paramount significance so as to assess the impact of environmental parameters on the efficacy of the formulation as well as impact of the formulations on non-target fauna. In the present study Annona formulations were evaluated against anopheline and culicine mosquito larvae from some villages of Muheza district in North Eastern Tanzania. Formulations of *Annona squamosa* collected from central coastal regions of Tanzania were evaluated against laboratory reared *An. gambiae* s.s. and *C. quinquefasciatus* at laboratory and wild collected anopheline and culicine larvae in mosquito sphere. The larvae and their associated invertebrates cohabiting in the same habitat were treated by the formulated botanical larvicides at concentration 100µg/ml. Physic-chemical parameters were measured during scoring of mortalities. Percentage larvae reduction was done by using Mullas' formula. Cumulative percentage reduction of abundance of non-target invertebrates was calculated using MS Excel. The formulations showed high efficacy against anopheline larvae reaching 100% and 89% larvae reduction in 3 days post exposure for leaf powder from central and coastal regions respectively. The activity of leaf powder form central region against culicine larvae was lower (50%) compared to that from coastal region (88%). Larvae reduction after re-introduction was lower in both formulations. The formulations had no significant impact on the physico-chemical parameters of water from which larvae was collected. The formulations had minimal effects on survival of most selected non-target invertebrates except for some members from order Ephemeroptera (Mayflies). The formulations evaluated showed efficacy in the laboratory as well as field conditions, they were not affected by environmental factors. The formulations had low impact on most of non-target invertebrates.

[S3-18] Non-communicable diseases and their management in the Lake Victoria basin, Kenya

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Usage of plants as source of medicine remains common despite the current growth and expansion of conventional medicine and health centres in many parts of the country and particularly in the rural areas. Traditional medicine practitioners still remain the resource persons to health problems of many, especially in cases where the sick have consulted the conventional medicine with no success. The other reason for the popularity of the traditional medicine practioners is the fact that their services are affordable and payment does not have to be monetary, but it can be in the form of an animals or crops as per the agreement. In search for plants used for treatment of microbial related ailments such as malaria, sexually transmitted illnesses, diarrhoea, pneumonia, a lot of information given by the herbal practioners interviewed was also on plants used in the management of the non-communicable diseases. This paper presents data on the treatment of non-communicable diseases using medicinal and pesticidal plants in the Lake Victoria region.

[S3-19] Larvacidal compounds from *Fagaropsis angolensis* against *Anopheles gambiae*

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Anopheles gambiae mosquitoes transmit malaria resulting into about 500 million infections leading to approximately 1.2 to 2.7 million deaths globally every year. Recent studies estimate that more than 50% of the worlds' population is at risk of malaria infections. Apart from the development of insecticide resistance, use of synthetic insecticides to control mosquitoes continues to cause adverse effects to the environment, human health and non-target organisms. Plant derived larvicidal compounds are increasingly being explored as possible alternatives in vector control methods. This study investigated the potential larvicidal activity of both essential oil and non-volatile compounds from *F. angolensis* leaves. The plant belongs to Rutaceae family and traditionally has been used as medicine in treating various ailments. The chloroform extract of the non-volatile compounds was subjected to a series of bioassay guided fractionation and purification steps using chromatographic techniques. The F. angolensis leaf essential oil was obtained by hydro-distillation and identified by GC-MS. Three larvicidal compounds namely a phenanthrene carboxylic acid derivative (**1)**, Hexyl-9, 10-dihydroxydec-5-enoate (**2)** and Methylheneicosane ester derivative (**3**) were identified using spectroscopic techniques. The compounds **1**, **2** and **3** exhibited LC_{50} values of 245.5 mg/L, 147.6 mg/L and 144.4 mg/L respectively when tested against the third instar *A. gambiae* larvae. Their LC_{90} values were 471.6 mg/L, 292.1 mg/L and 259.4 mg/L respectively. The oil showed LC_{50} and LC_{90} values of 83.7 mg/L and 324.0 mg/L at 95% confidence interval. Eight compounds were identified from the oil including 5-Chloroindole, N-methyl-p-chlorobenzenesulfonamide and 1-Butyl-2-ethyloctahydro-4, 7-epoxy-1H-inden-5-ol which have been previously reported to possess insecticidal activities. Results of this study indicate that the isolated compounds and oil of F. angolensis can be used in the development of natural mosquito larvicides which can be used in malaria control programs.

[S3-20] Room for plant derived pesticides in agroecological management of crop pests? Experience from West and Central African food and horticultural crop-based cropping systems

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Plant-derived pesticides are part of the toolbox of IPM and organic agriculture, as substitutes to synthetic chemical pesticides. On the other hand, for the very same reason (substitution rather than re-design), they are less in line with the agroecological approach. We however provide examples of the potential role of such plant-derived pesticides (with emphasis on extracts of neem and Jatropha), in a strategy of pest management via agroecological pathways. These encompass seed-dressing for Black-beetle management on upland rice in Madagascar, sprays for management of sorghum stem-borers in Mali and Cameroon, of sorghum panicle-feeding bugs and cotton bollworm in Mali, and of cowpea pests in Niger. The way the plant-derived pesticide-based tactics can be synergistic rather than conflicting with the agroecological pest management strategy is discussed mainly along the following two lines: i) Potential integration of botanical pesticide-producing plants in the cropping system (e.g. Jatropha live-hedges around vegetable market-gardens in Niger); ii) Pro's and con's of the use of such repellent, deterrent, and/or biocidal extracts in an "assisted" push-pull strategy.

[S3-21] Effect of herbal plant extracts on *Trypanosoma brucei rhodesiense* infected mice

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In Kenya, although sleeping sickness has been thought to be under control, in recent times there have been reports of cases of *T. b. rhodesiense* sleeping sickness reported in tourists visiting the Maasai Mara. Available treatments for the disease have poor efficacy and safety outcomes especially in late stages of the disease with the parasite in the central nervous system. The pathology of this disease is mediated by host inflammatory responses. These responses cause tissue damage through production of reactive oxygen species and consequently increase the severity of the infection. Tissue inflammatory damage during trypanosomosis significantly affects the treatment and prognosis. This study investigated the anti-inflammatory effects of water extracts of *Solanum nigrum* (SNE) on mice infected with *T. b. rhodesiense*. Six groups of 5 mice each were infected and 4 groups treated with varying concentrations of the extract. The fifth group was treated with dexamethasone while the sixth group was not treated. The anti-inflammatory activity of the extract was tested by measurement of albumin and the disease progression monitored by measurement of packed cell volume, parasitaemia and body weight changes. The SNE extract produced significant anti-inflammatory activity compared to dexamethasone as measured by the significant higher levels of acute phase protein albumin in the former group of mice. At the same time the SNE treated mice had a significantly higher packed cell volume and lower parasitaemia levels compared to the untreated counterparts. The results suggest that SNE extract protected mice against trypanosome induced inflammatory tissue damage and hence reduced pathogenesis of trypanosome infection in SNE treated mice.

Symposium 4 Biopesticide technologies Plenary

[S4-PL] Botanical insecticides: an Asian perspective

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In spite of the significant progress over the last four decades towards greater food security in several regions of the world, around 850 million people remain malnourished. Therefore, on one hand, we face a gigantic task of ensuring environmental and food security in the twenty-first century and on the other, we have to protect crops from pests in order to get maximum yields. The use of chemical pesticides is not a strategy without problems as they have caused serious ecological damage. In this context, there is a strong need to promote eco-friendly technologies in agriculture and use of biopesticides has been one of the strategies, as their market is suggested to reach US$ 3.4 billion by 2017 (new report by Global Industry Analysts, Inc.). Natural products from plants make one of the components of biopesticide strategy that has to play a prominent role in sustainable crop production. During the last two decades, allelochemicals from plant bio-resources have been heralded as desirable alternatives to synthetic chemical insecticides for pest management because they reputedly pose little threat to the environment or to human health. Another reason is that plant-based products have been a focus of interest of chemists and biologists because of their structural complexity, potency, and selectivity. Over 200,000 metabolites are currently known, which are estimated to account for roughly 10% of the possible number of these compounds in nature. In most cases their structures, functions, and uses have not been sufficiently evaluated. In general, these compounds do not take part in basic metabolism, but are essential to the plant by mediating plant–plant and plant–herbivore interactions. Thus, several important types of insecticide are derived from or are analogues of plant products and discovery and use of phytochemicals is a highly active area of science but one that often is shrouded in commercial confidentiality. In recent past lot of emphasis has been on the diverse compounds from various plant bioresources to provide the compounds like limonoids from neem and other rutales, rocaglamides, naphthaquinones, piper amides, annonins, sugar esters, etc. During last decade, interestingly many monoterpenoids, phenylpropanoids and alcohols from essential oils of plants have been demonstrated to possess significant commercial potential as biopesticides.

From Asian perspective, Asia-Pacific countries are the leading advocates of biopesticides. Despite considerable research and development efforts, their use has remained limited to only 2.5% of the total chemical use. China is the largest biopesticide market in the region, followed by India and Japan. The majority of the products available for use in these countries have been researched, developed and manufactured locally albeit, often, with advice and assistance from NGOs or government. In China, during past 20 years, domestic enterprises have put a lot of

manpower and resources to carry out the development of botanical pesticides and achieved remarkable results. Rotenone, matrine, nicotine, toosendanin, veratridine, limonin, eucalyptol and azadirachtin from neem are registered products in China. According to statistics, there are 13 provinces where various kinds of plant-pesticide products are manufactured. Korea and Japan and some other Asian countries have introduced the use of botanical pesticide subsidy policy and are considering reduced data requirements or waivers for products of this type, particularly for use against public health pests where food residues are not at issue.

Neem, which has been a major botanical marketed product in recent years, has yet to be approved for use in the Philippines, where pyrethrum is the only approved botanical insecticide. In South Korea ECOWIN is producing botanicals based on neem and essential oils and even extending marketing collaborations with Turkey and Malaysia. In Thailand, Department of Agriculture is trying to regulate the use of botanicals and lot of emphasis has been on pyrethrum, neem and some essential oils in recent years. However, botanical insecticide development under specific regulatory authority is still lacking in this country.
In India, four botanical biopesticides are registered under the Insecticides Act, 1968 of which only neem, *Azadirachta indica* holds potential for a large scale use in agriculture. Over 450 azadirachtin based products are registered. The estimates show that about 2.7 million litres/1000 tons of Aza based pesticides are reportedly used per annum. These control a wide range of pests on a number of crops including pulses, vegetables, turmeric, ginger, rice, cotton, jute, sorghum, fruits, coffee, tea, and flowers. Our recent studies have demonstrated that combination of compounds from various plant bioresources can be exploited for inhibition of behavioural responses of insects and such compounds need to be exploited with a broader perspective than just toxic potential. Our studies have also demonstrated that toxicity plays an important role in predicting host plant choice, but behavioural response in terms of oviposition preference is independent of toxic action, particularly for non-host toxins. Thus, the same compounds affecting oviposition behaviour on the one hand and having ovicidal or feeding deterrent properties on the other could be useful in field situations in any area-wide integrated pest management model. Therefore, it is not only plant biodiversity that needs to be looked into as a bioresource for pest management, but also the diversity of modes-of-action that such plant products can provide. The enlightened approach of the Central Insecticides Control Board of India has greatly helped the spread of biopesticides in India. The Board simplified the registration system to allow commercial pilot production in parallel with registration. This is particularly encouraging to small and medium enterprises and biotechnology start-ups that are keen to take advantage of the new technology and know-how.

Symposium 4 Biopesticide technologies Session talks

[S4-1] Growing conditions and developmental stage influence the emission of potential miticidal volatile compounds from leaves of *Gynandropsis gynandra* L. (Briq)

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We recently reported the emission of spider mite repellent methyl cyanide (acetonitrile) from intact plants and detached whole leaves of the African spider plant (*Gynandropsis gynandra* L. (Briq) and liberation of a blend of volatile compounds, which are toxic to the spider mites (*Tetranychus urticae* Koch) from its homogenized leaves. This study employed static and dynamic headspace sampling and gas chromatography-mass spectrometry (GC-MS) to evaluate the effect of greenhouse and field conditions, seasonal variations, and developmental stage on the emission and abundance of these potential miticidal compounds in the leaves of *G. gynandra* accessions. The level of methyl cyanide emission from the detached whole leaves of the *G. gynandra* accessions was similar under both field and greenhouse conditions in 2009. The greenhouse grown plants, however, emitted significantly higher amounts of methyl cyanide in 2010 than 2009. The increased emission of methyl cyanide in 2010 coincided with summer conditions of long photoperiod and high temperatures especially the growing degree days. The levels of isothiocyanates (propyl-, methyl-, butyl- and isobutyl-), 2,4-heptadienal and β-cyclocitral were significantly higher at the vegetative (day 32 after sowing) than the reproductive (day 118 after sowing) stage of development in all the *G. gynandra* accessions. Generally, the abundance of (Z)-3-hexenal was higher at vegetative than the reproductive stage in all *G. gynandra* accessions and the pot rose while the levels of (E)-2-pentenal, 2-octenal, (Z)-2-pentenol and β-ionone were more or less the same at both stages of development. These results provide guidance for: exploiting methyl cyanide emission for enhanced repellent efficacy of *G. gynandra* in companion planting or intercropping systems, and determination of the right stage for potential utilization of the plant for biopesticide extraction or biofumigation.

[S4-2] Innundative biocontrol of water hyacinth (*Eichhornia crassipes* (Martias Solms) Laubach)) using zonate leafspot (*Acremonium zonatum* Sawada Gams) fungal agent

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Innundative (tactical, bioherbicidal or mycoherbicidal) approach of biocontrol involves culturing spore inoculum in artificial media, harvesting, concentrating and formulating it in order to withstand storage and handling so that it can be applied to the weed in the same way as a chemical herbicide. A trial was set up in Maseno University glass house to test the effect of concentrating and formulating *A. zonatum* spores in vegetable oil, mineral oil, pure commercial grade glycerol and tween 80 for use in water hyacinth biocontrol. *A. zonatum* was isolated from infected plants collected from Winam gulf of lake Victoria. The isolates were cultured on PDA under aseptic conditions. Koch's Postulate was used to confirm that the isolate was A. zonatum. The isolate was subsequently multiplied on several PDA plates and spores harvested when mature. Using a count chamber, the spores were concentrated into four levels; 10^5, 10^6, 10^7 and 10^8 spores/ml and formulated in 4 different oil emulsions. Healthy water hyacinth plants with five fully expanded leaves were collected from Winam gulf, placed in 3ft diameter plastic basins and taken to the glass house to acclimatize for 4 days. The plants were injured and inoculated. They were set up in a RCBD experiment replicated 3 times. The results show that concentrating and formulating *A. zonatum* in vegetable oil and mineral oil enhances its efficacy. There is extensive leaf infection but new leaves continue to form. *A. zonatum*, concentrated and formulated can be used in the control of water hyacinth but in an integrated approach with insects (*Neochetina eichhorniae*).

[S4-3] Biopesticides and their commercialisation in Africa

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The road to the widespread use of biopesticides is a long and complex journey. Many promising biopesticide candidates never reach the final stage when they are commercialised and adopted legally for use by the farmer. The Real IPM Company (K) Ltd produces and commercialises biopesticides in different countries in Africa. The aim of the paper is to highlight the challenges and country differences of commercialising biopesticides in various parts of Africa. Unlike Europe where the process of crop protection agent registration has been harmonised across the EU, most African countries currently have national approval schemes. However, there are moves to develop regional registration systems. Examples will be taken from a range of countries and regions including West Africa and East Africa. In any crop protection product, two key criteria that should be assessed are a) the safety of the product to the operator, the consumer and the environment, and b) effectiveness of the product. When commercialising crop protection products including biopesticides, there is a legal requirement to obtain regulatory approval for their use. The process of regulatory approval will be described and examples drawn from different countries. In addition, the challenges that biopesticides face in obtaining regulatory approval will be discussed. The paper will conclude with highlighting the key stages and decision processes involved in commercialising biopesticides and give pointers on how to successfully commercialise a biopesticide.

[S4-4] Seed treatment with a binary pesticide or aqueous extract of *Eclipta alba* (L.) Hassk. for improving sorghum yield in Burkina Faso

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Seed treatment with an aqueous extract of *E. alba* or the pesticide, Calthio C, showed to have a significant potential for controlling seed-borne fungi and improving yield of sorghum in Burkina Faso. Seed health testing and field trials were carried out in Burkina Faso, to evaluate the effects of seed treatment with aqueous extract of *Eclipta alba* and a binary pesticide Calthio C 50 WS (thiram 25%, chlorpyrifos ethyl 25%) on seed-borne fungi, seedling emergence and yield of sorghum. Treatments included: soaking seeds in *E. alba* extract (6.25 to 25% concentrations), soaking seeds in water, dusting seeds with pesticide (4 g kg^{-1} of seeds) and no treatment. Seed samples with moderate to high infection levels of *Curvularia Boedijn*, *Fusarium link* and *Phoma sorghina* were used for testing. *E. alba* extract and Calthio C caused significant inhibition of *Leptosphaeria sacchari* Breda de Haan (syn. *Phoma sorghina* Sacc.) in vitro. In field trials, a stimulatory effect on seedling emergence and yield increases of 7 to 38% were observed for E. alba and pesticide treatments as compared to no treatment. Yield increases were significant for plant extract and pesticide in two out of three trials. No consistent effect on yield was observed for water treatment. Our findings represent the first large scale field testing of *E. alba* in seed treatment of sorghum and the first direct comparison with a thiram-based pesticide and seed priming.

[S4-5] Sustainable use and cultivation of *Carapa procera*, a useful species in human and animal health in West Africa

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Carapa procera DC. (Meliaceae) is a species widespread in the woodlands of Africa and Latin America. In West Africa, rural populations exploit its medicinal properties by using the plants' leaves, fruit, seeds, bark and roots. For example, the bitter oil of *Carapa* seed (55% of dry weight) is an important ingredient in pest control for the organic production of cotton and other crops in West Africa. This widespread use exerts pressure on populations of the species, as natural regeneration and survival in the wild are very low. The physiology of *Carapa* seed was investigated in order to develop propagation techniques for reintroduction and enriching village woodlands. The results showed that seeds freshly harvested in April-May (state period from harvest and not months) contained about 50% water content and over 90% germinated without any pre-treatment. When seeds were dried at 25˚C in a ventilated room, their water content dropped to less than 20% within two weeks, completely undermining their ability to germinate. These seeds therefore exhibit recalcitrant storage behaviour. However, when stored with a mixture of wood chips, 50% of seeds germinated after a month and 23% germinated after three months, and the water content stayed above 35%. In nursery production, the use of substrate made of soil/compost/clay/loam allowed seedlings to grow to heights of ≥40cm after three months. These seedlings reach an average size of 55cm before transplanting them to fields at the start of the rainy season in June-July, so that they can be cultivated and domesticated. A *C. procera* plantation is fully established after three rainy seasons. These results inform best practice for handling seeds and establishing plantations of *C. procera* for the sustainable use and conservation of the species.

Symposium 5 Commercialization, policy Plenary

[S5-PL] Intellectual property and policy for the commercialization of pesticidal plants

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With the emergence of the knowledge economy, intellectual property rights (IPR) have become an important component of the innovation system. The role of the IPR system in stimulating and promoting innovation has been empirically demonstrated in the developed economies where it is integrated in the economic system. However, integration of an IPR system in the innovation system in Kenya and Africa, in general, has not been very effective due to a variety of reasons. Firstly, the lack of knowledge and misconceptions about Intellectual Property Rights and their roles in the innovation process has been a big limitation. The consequence of which has been limited use of IP information in research and development. Secondly, legal, policy and institutional gaps in the IP systems renders the innovation system to perform sub-optimally. Inadequate IP skills and services to facilitate IP management decisions are not readily available to the researchers and managers in research institutions. Consequently there is inadequate commercialization and leveraging of research outputs. The focus of the presentation will be to highlight IP issues and possible approaches for managing such issues in development and commercialization of research outputs (innovations) with special reference to pesticidal plant technologies.

Symposium 5 Commercialization, policy Session talks

[S5-1] Botanical pesticides production, trade and regulatory mechanisms in sub-Saharan Africa: making a case for plant pesticide products

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Sustainable pest management is crucial for successful farming in sub-Saharan Africa as most economies are heavily dependent on agriculture which has intensified the use of pesticides. However, farmers in this region repeatedly complain that synthetic products are unaffordable, unavailable, poorly labelled or packaged, frequently adulterated and sometimes sold after expiry date. Coupled with health and environmental hazards posed by the misuse of synthetic pesticides, there is now considerable interest in the application of botanical pesticides for crop protection. Botanicals are biodegradable and less persistent in the environment and their use should lower risks to health and development of resistance. This paper presents results of a study conducted in sub Saharan Africa aimed at understanding the potential production marketing and use of botanical pesticides. Site specific investigations were carried out to represent East, West and southern Africa using key informant interviews and synthesis of existing documentation. The study revealed that, despite the increasing interest in botanical pesticides, their commercial production remains limited. Several reasons have been suggested for the limited production including; i) lack of data on the efficacy and safety; ii) no ready to use products; iii) inconsistent performance of crude extracts and iv) lack of clear practicable registration procedures. The demand for botanicals is poised to grow due to an increasing shift in consumer demands for safe food, increase in organic farming and lobbying from environmentalists. These demands can only be met by overcoming the restricted ecological distribution of certain plant species, improving the productivity of bioactive constituents, meeting the challenges posed by existing registration requirements and formalising their production, use and marketing. This suggests that regulations and protocols for production, their evaluation and promotion would have to be reviewed to facilitate the development of the botanicals sector in Africa.

[S5-2] Governance structures for bridging the access and utilization gap of bio-pesticides produced by different farmers in Tanzania

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Tanzanian communities have multitude of bio-fertilizers and bio-pesticides synthesized from different varieties of plants to solve challenges of pests and soil nutrients depletion. Opportunities for value addition exist to help access and commercialisation of these plant extracts to be used by farmers who produce high value crops. There are different disparities for production, utilisation and accessibility of these bio chemicals for example no commercial production in areas where materials are available to feed demand in areas where they are not. Governance structures determine their value addition for commercialization, adaption and availability in other areas where bio chemicals are not produced and therefore needed to be understood. The study utilised data collected during a Masters Study on governance of global value chains for organic ginger export, and PHD study on networks and organisation of organic vegetable farmers in North Eastern circuit of Tanzania and also from NGOs by reviewing documents, interviews and observations. The farmers were in two categories; one: the Usambara Lishe Trust (ULTFs) and Umwima farmers that are found in the valleys of Usambara mountains and Zanzibar respectively. Secondly groups producing the bio chemicals individually and indeed utilising them; these are under Tushikamane (Morogoro) and Florester (Kilimanjaro).The Umwima and ULTFs are organised and receive training such as synthesis of the chemicals from Local Government authority. They keep on developing their skills through sharing local experience in the control of pests and soil fertilisation. However, farmers under Tushikamane and Floresta receive training and experience within themselves and NGOs. Governance structures such as property right issues, quality considerations, and networking issues were important for exploitation of the commercial opportunities of bio pesticide produced by different farmers.

[S5-3] Revamping the pyrethrum sector through improved policy environment to address pest problems anticipated due to climate change and to improve farmers' livelihoods

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The Eastern Africa region is the hub of pyrethrum production in the world, as it grows optimally and the oil extract levels are high. It is also a natural insecticide and the pyrethrin extract is used in many insecticidal products for domestic and crop use. According to IFAD (2004), pyrethrin production supported the livelihoods of over 200,000 Kenyan family households, with many having land sizes of about an acre. Pyrethrum is a perennial crop typically left in a particular crop for 3 to 5 years, before crop rotation. The length of time is often dependant on pyrethrum production volume in a given year, with production decreasing by 30% each subsequent year. Pesticides worth more than 30 million US dollars are intentionally released into the global environment every year. Many of these are highly toxic and have immediate adverse effects on human health, wildlife, local food sources such as cattle or fish, beneficial insects and biodiversity. Several of them have chronic effects including cancers, reproductive problems, birth defects, hormonal disruption and damage to the immune system. Impacts come from direct exposure in use, spray drift, washing work clothes used while spraying, home pesticide storage, pesticide dumps and persistence in the environment. Pyrethrum is an ideal pesticide in the current increasingly environment conscious climate because it naturally degrades as compared to the synthetics which have by and large formed the ingredients of these pesticides. It is therefore forms part of the major strategies for climate change mitigation and adaptation.

[S5-4] Assessment of international provenance trial of *Azadirachta indica* in the Terai Region of Nepal

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Azadirachta indica A. Juss. belongs to Meliaceae family and is a multipurpose tree containing azadirachtin and other pesticide components. An international provenance trial of *A. indica* was established in July 1996 at Butwal Research Station of western Terai region of Nepal. It comprised the seed sources of 23 provenances collected from 10 countries including Nepal. A randomized complete block design was used for the experiment with two replications in an area of 1.5 hectares. The objectives of this trail were similar to that of other provenance trials under the International Neem Network. The assessments were made for survival rate, diameter at breast height (DBH), height, crown diameter and straightness of stem at age 5 and age 10. Average survival rates of the provenances in the two assessments were 69.74% and 63.5% respectively. The survival rate ranged from 33 % for Kuliyapitiya, Sri Lanka to 92 % for Ramannagudu, India. The four provenances Ramannagudu, Sagar, Sunyani, and Lamahi showed ≥ 80% survival rate. Similarly, Sunyani, Ban Bo, Yezin, Ramannagudu and Doitao showed best performance for DBH. The mean DBH of provenances was 8.74 cm (SD = 2.07). The five provenances namely, Sunyani, Yezin, Ban Bo, Ghaati and Bandia were the best performer for height. The mean height and SD of provenances were 6.29 m and 0.79 respectively. Sunyani had the widest crown diameter at both ages. Ban Nong showed the highest score for the straightness of main stem. Out of the two local provenances of Nepal, Lamahi showed better performance than Geta in many characteristics.

[S5-5] Economic evaluation of optimized pest management options on bean cropping systems in southern Africa

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Cowpeas (*Vigna unguiculata*) and common beans (*Phaseolus vulgaris*) are very important as sources of protein, micro-nutrients and essential vitamins particularly for poor households in Southern Africa. The yields of these crops are, however, chronically low, often <400 kg ha^{-1}, largely attributable to insect pests and disease. While new varieties have improved yields, increasing productivity will only happen with effective pest management and this remains one of a few constraints over which farmers have some direct control. Economic analysis was carried out to determine the economic viability of pesticidal plant products in beans cropping systems. Data for this was collected from agronomic trials carried out in 2010 - 2011 cropping season in Malawi. In determining the most economically acceptable treatment, partial budget analysis and Marginal Rate of Return analysis were carried out to estimate the gross value of the component crops using the adjusted yield at 2010-2011 market prices for the crops and inputs. Results showed that higher net returns were obtained from higher net benefit of MK 431, 756.67 and MK 428, 584.47 were obtained from synthetic pesticide and *Vernonia amygdalina* 2% in kasungu, synthetic pesticide and *Vernonia amygdalina* 2% returned higher net benefits of MK 248, 037.67 and MK 229, 119.97 respectively in Mzimba and In Rumphi higher net benefits of MK 64, 148.30 and MK 62, 537.00 were obtained from V. amygdalina 2% and synthetic pesticide respectively. However results of the MRR analysis indicated that farmers stand to gain better if they change from not using any pesticidal product to using pesticidal plant products especially those treatments diluted with soap.

[S5-6] Bioprospecting for phytochemical control agents of the stored product pest, *Prostephanus truncatus* (Horn) (Coleoptera: Bostrichidae) from some western Kenya flora

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Essential oils from twelve plants representing Labiatae, Compositae, Verbenaceae and Euphorbaceae families have been evaluated for their potential to protect dry maize and cassava chips as fumigants and contact insecticides of the larger grain borer, *Prostephanus truncatus* (Horn). The tests were done at five levels (0.625, 1.25, 2.5, 5 10%) of % dilutions in hexane and with ten adult larger grain borers for each test. The mortality data of the insects at each level of dilution, which was replicated 4 times, was collected and the mean values computed and subjected to Students-Newman-Keuls (SNK) t test. Six oils were tested as fumigants of the insect in cassava chips. It was observed that within the 0.625% level of dilution, the oil extracts showed some significant difference (f=3,26; P=0.0078) in their effect on the insects mortality. The mean mortality due to Tagetes minuta effect (1.67) was numerically higher compared to *Croton dichogamus* (1.60) and *Conyza newii* (1.60), which were similar; *Lippia ukambensis, Artemisia annua* and *Torchananthus camporatus* were intermediate with no statistical significant difference from *Tagetes minuta, Croton dichogamus* and *Conyza newii*. Another significant difference (f=4.07, p=0.0086) was observed in the fumigation tests done with the dry maize using some other four different plant essential oils from Labiatae family and within the same concentration level of 0.625% of oils. Of the four plants oils, *Plectranthus marrubioides* gave a higher mortality (1.70) than *Ocimum lamiifolia* (1.64) and *Ocimum suave* (1.63) with *Torchananthus camporatus* (1.69) as intermediate but with no statistical difference between it and the other three labiatae plants. In the contact toxicity assays with the above plant oils a similar trend of activity as shown above was observed. These results suggest that these plant oils have the potential for development into post-harvest control agents of the larger grain borer in stored grain products.

[S5-7] Translating science into community life: An experience at the Institute of Traditional Medicine

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Communicating bioscience to the community has always been a difficult task if proper mechanisms are not put in place. In most cases, research findings are not translated into application to be used by community members especially in rural settings. In order to bridge what is being communicated in scientific world to the community, a simple methodology of formulating Annona biopesticide to be used by the community has been developed at the Institute of Traditional Medicine. To adopt bioscience formulation principles and translate them into simple useful formulation for mosquito control of immature mosquitoes. Interviews were done with the community to identify some useful plant species used for mosquito control. Plant materials were collected and tested in laboratory and semi-field conditions. Standardization was done, followed by formulation using non-economical materials available to the peoples' vicinity. Show case to demonstrate their efficacy was done through training workshops. Awareness and training workshop to exchange ideas with stakeholders on issues pertaining to pest control especially control of malaria vectors using botanicals as a complementary tool in the Integrated Vector Management (IVM) received attention of the community members, policy makers and implementers through group sensitization workshop, meetings/discussion and show cases as will be discussed. Involvement of stakeholders in every developmental stage of the bioprospecting research is of important as they may act as research outcome delivery tools to inform others such as policy makers. Furthermore, proper translation of formulations principles by using locally available and accessible materials would result in value added botanicals.

Symposium 6 Propagation and conservation Plenary

[S6-PL] Conservation and propagation of pesticidal plants for sustainable use

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Since the advent of the green revolution, farmers have consistently used modern chemical pesticides which often have devastating effects on the natural environment. Compared to plant based pesticides, many of these modern chemical pesticides end up polluting food and water sources that may be directly or indirectly linked to human health. To counter risks arising from the use of chemical pesticides, there is a realization that pesticidal plants are now integral to human development since they offer ecological, health, social, economic and environment benefits to rural and resource poor communities particularly in developing countries. The aim of this review therefore is to provide a concise and detailed understanding on the conservation and propagation of pesticidal plants for sustainable use. Precisely, the review identifies many pesticidal plants used by communities and where possible their site and off site based conservation methods that underpin their sustainable use. Importantly and to the extent of availability, case studies for the pesticidal plants conservation in modern repositories (seed banks, herbaria, botanic gardens, DNA banks), on-farm systems (boundary planting, trees on-farm) and off site methods particularly national parks and reserves are discussed. The merits and demerits of each conservation method in the review are briefly outlined. As appropriate, the pesticidal plants conservation approach is linked to the documented plant propagation method for various species (use of seeds, cuttings, offshoots) since this ensures their continued management for posterity. Priorities and ways forward on pesticidal plants conservation, propagation and use is provided through a range of conclusions as a way of encouraging exploitation of these plants by communities at landscape level and importantly, across the entire species value chain.

Symposium 6 Propagation and conservation Session talks

[S6-1] Prospects for a rapid in vitro regeneration system for propagation of the pesticidal tree *Melia volkensii* Gurke

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Melia volkensii Gurke, a drought-tolerant tree native to East Africa, has under-utilized potential as a source of botanical pesticides. Its leaf and fruit extracts have larvicidal, growth retarding and anti-feedant effects on mosquito larvae and locusts. *M. volkensii* has been over-exploited for its valuable timber, hence the need for conservation through domestication. However, production of adequate planting stock is constrained by difficulties in propagation via seed and cuttings. There is no protocol for large scale clonal propagation of the species via tissue culture. The objective of this study was to develop an in vitro culture protocol for rapid and efficient propagation of *M. volkensii*. Mature zygotic embryos were aseptically cultured on Gamborgetal's B5 medium containing 0 to 4 mg/l of the plant growth regulator Thidiazuron. High frequency callus induction (96.7 to 100%) was achieved within 5 to 10 days. Callus sub-cultured to hormone-free ½ MS or B5 medium formed multiple somatic embryos which grew into micro shoots. ½ MS was superior to B5 medium for induction of somatic embryos. One way analysis of variance showed that Thidiazuron concentration had no significant effect on callus induction but significant effects ($p < 0.001$) were observed on fresh mass of callus and somatic embryo induction. Micro shoots elongated well on B5 medium containing 0.1 mg/l Benzylaminopurine plus 5 or 10% (v/v) coconut water. Frequent multiple shoot induction, in the range of 4 to 12 shoots per initial shoot, was observed on the elongation medium. Shoots obtained were phenotypically normal. This protocol took 3.5 months to produce shoots ≥ 5.0 cm in height. Further work is in progress to attain rooting of the shoots. This study offers a simple protocol that could be optimized for exploitation in large scale in vitro cloning of *M. volkensii* mother trees with elite genotypes and phenotypes.

[S6-2] Harnessing pesticidal plant technologies for improved livelihoods

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A survey in 2006 was used to obtain farmers' perceptions of pest control in the field and storage in Mali. The regions surveyed were Koulikoro in the South Central, Ségou in the Center, and Sikasso in the south of Mali. A total of 19 villages (four in the Koulikoro region, 10 in Ségou region, and five in Sikasso region) were considered. Ten farmers (seven men and three women) were interviewed per village. Pest control methods used in the field and storage were included in the questions. The result showed that of 190 farmers interviewed, 167 used a control method against pests in the field and 23 did not use any method of control. Sixty-eight farmers used local plants or plant structures to control storage pests in their granaries. Among the farmers, some thought the local plants were efficient while others thought local plants were not efficient but could not afford to buy insecticides to control pests. About 15 botanical plants were used by farmers to control pests in the field and storage. Different parts of the plant (leaves, barks, and fruits) or the entire plants were used. Most farmers in Koulikoro and Ségou thresh the sorghum and millet and keep the seeds in bags or granaries, while in Sikasso, most farmers kept sorghum panicles and millet spikes in the granaries. Clay granaries were most common in all three regions. Clay was either used alone or in association with other material.

[S6-3] Ethnobotany, propagation and conservation of medicinal plants in Ghana

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Medicinal plants and plant-based medicines are widely used in traditional cultures all over Ghana and they are becoming increasingly popular in modern society as natural alternatives to synthetic chemicals. In view of this, this project studied the ethnobotany of medicinal plants through socio-economic survey, their propagation and conservation in Ghana. It was found that herbal medicine industry is a major source of income for over 80% of the respondents. Almost 50% of the respondents were women with majority of them involved in marketing of the medicinal plant products. Out of 160 plant species marketed in Ghana, 129 are collected in Ghana with Kumasi and Accra being the major marketing centres. Most of the species have multiple curative properties with over 46 diseases being cured by herbal medicine in Ghana. Due to the high demand, over 100 species were reported as being scarce or unavailable. Some of the major causes are lack of cultivation, unsustainable harvesting, deforestation, wildfire and urbanization. Studies on seed germination showed that seven species out of the ten selected species had good germination, ranging from 40-74% with an average of 63.3%. This suggests the possibility of cultivating medicinal plant species on commercial scale. Based on the results, it was suggested that, linkages between all stakeholders be strengthened in order to promote conservation and commercial production of medicinal plants. Furthermore, improving the knowledge-base of scientists, traditional herbal medical practitioners, policy makers and the public on the relevance and safety of traditional plant medicine could lead to the sustainability of medicinal plants industry in Ghana.

[S6-4] Environmental conservation and climate change: Mitigation and adaptation in relation to pesticidal plants

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The climatic uncertainties and observed surprises, emanating as more frequent and severe quick-onset storm and flood disasters, including heat waves and the prototype slow-onset disasters such as droughts in more recent decades, can be traced to previous natural resources management policies. It was then assumed that ecosystem dynamics were linear, predictable and controllable; human and natural systems essentially separate entities, rather than as complex, strongly linked, evolving integrated systems. Adopting climate change definitions from the Intergovernmental Panel on Climate Change, as they represent the widest consensus on climate change terms available, the author underpins the potential significance of projected changes in the environment resulting from the linked natural and human factors. The paper amplifies concerns for putting in place adaptive processes which include development and commercial use of biopesticides, feedback learning and flexible partnerships with local communities in environmental governance around the concept of adaptive co-management rather than using an authority-driven command-and-control approach. Contrary to misguided views that plant extracts are ineffective in controlling pests in growing crops, crop products in storage, livestock and human disease vectors, effective active ingredients identified in laboratory analyses confirm efficacy of specific local plant extracts. Principles of equitable environmental governance, especially in areas of high natural resources dependency should therefore be transparently promoted. Finally, the author calls for natural resources management approaches that, while accommodating uncertainty, can sustain social-ecological systems even during periods of transformation following especially quick-onset disasters. Pesticidal plants can make significant contributions in this regard in normal and disaster settings especially in Africa, where such impacts of climate change are projected to become most severe. Transparent and flexible institutions and organizations are needed that can facilitate participatory learning and build adaptive capacity in local communities for disaster recovery and development leading to food security, improved livelihoods and poverty alleviation.

[S6-5] Increasing stewardship of ethno systems in Zambia

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Traditional medicine has been used in Zambia as a culture handed down over generations yet no systematic documentation has been undertaken. At global level it is estimated that more than 67% of the world populations rely on traditional medicines while at local level there is insufficient appreciation of this valuable knowledge. The absence of well-documented profiles of indigenous knowledge remains a major limitation to improvement and integration of traditional medicines into formal health delivery system. This paper presents results of a study on ethno-botanical perspective of traditional medicine in Zambia. It is largely informed by literature review and field interviews that were conducted in Lusaka and Copperbelt provinces. The findings are that there is apparent knowledge degradation and decreasing use of indigenous plant medicines attributed to expiry of holders of such knowledge. Worse still the reliance of oral record of such important information has witnessed a tremendous degradation over the years. Lack of deliberate efforts to collect, collate and promote indigenous technical knowledge threatens its perpetuity. Indigenous knowledge in Zambia remains relic to rural communities or simply enthusiast. However, communities have remained ill-informed or are completely ignorant of subsistence and commercial benefits traditional medicines which include incentives for sustainable natural resource management. This is consistent with efforts enshrined in the national guideline for traditional medicine research in Zambia which was approved in 2010. In order to achieve the objective of supporting opportunities that enhance commercialization of traditional medicines and integration into the mainstream health delivery system it is recommended that accelerated action to document knowledge of traditional medicines be undertaken in order to rescue the remnant traditional plant medicine information held by reducing constituency of local people.

Posters Symposium 1 Pre-harvest

[PS1-1] In vitro and field evaluation of fungicidal properties of botanical extracts against *Rhizoctonia solani* and Phythopthora *infestans*

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The aim of the study was to evaluate plant extracts for antifungal activities against *Rhizoctonia solani* and *Phythopthora infestans*, important pathogens of potato which cause root rots and late blight diseases respectively. Acetone, ethyl acetate and water extracts of garlic (*Allium sativum*), Pawpaw (*Carica papaya*), Neem (*Azadirachta indica*), Mexican marigold (*Tagetes minuta*) and periwinkle (*Vinca rosea*) were screened in vitro for their antifungal activities against *P. infestans* and *Rhizoctonia infestans* using the disc agar infusion and microtitre double-dilution techniques. The same extracts were then tested for antifungal activity in vivo in the greenhouse on inoculated potato plants. The water extracts of *Allium sativum* and *Azadirachta indica* were active against *Phythopthora infestans* and had a minimum inhibitory concentrations (MICs) of 1.65 mg/ml. *Tagetes minuta* and *Vinca rosea* were effective against *Rhizoctonia solani* and MICs were 3.13 and 6.25 mg/ml respectively. MICs were of Allium sativum, *Azadirachta indica* and *T. minuta* acetone extracts were 0.78, 3.13 and 6.5 mg/ml respectively against P. infestans and 0.78, 6.5 and 3.13 mg/ml against *R. solani*. *Allium sativum* and *Azadirachta indica* water and acetone extracts performed well and they effectively reduced potato late blight and root rots in the greenhouse. These extracts compared well with the reductions due to application of Ridomil, a synthetic fungicide applied at 42.5gai/l and also with levels in the non-inoculated control. *A. sativum* and *A. indica* were effective both in vitro and in vivo in controlling late blight and root rots in potato and have a potential to be used as fungicides against these diseases. The plants are readily available and the extraction method is also simple and could lead to high adoption as fungicides by resource poor farmers.

[PS1-2] Evaluation of the fungi-toxicity of plant extracts against *Phythopthora infestans*

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Disease management by synthetic fungicides is often limited by their high cost, toxicity to the environment and the fact that certain pathogens develop resistance. Consequently, the present research work was based on the use of natural substances of plant origin to control late blight caused by Phythopthora infestans. The pathogen was isolated and culture on V_6- agar medium. The antifungal activity of plant extracts was evaluated on agar medium amended with various concentrations of the extracts. The EC_{50} and EC_{90}, the minimum inhibitory concentrations (MIC) and the area under standardized disease progress curve (SAUDPC) of plant extracts were calculated and compared to those of maneb. The MIC were 60µg/ml for *Syzgium aromaticum* acetone leaf extract, 85 µg/ml for *Eucalyptus saligna* methanol leaf extract and greater than 100µg/ml for *Cymbopogon citratus* methanol rhizomes extract, *Callistemon viminalis* acetone leaf extract and *E. saligna* acetone leaf extract. The in vitro efficacy of *S. aromaticum* (EC_{50}= 6.45 µg/ml and EC_{90}= 14.80 µg/ml) extract was comparable to that of maneb (EC_{50}= 5.45 µg/ml and EC_{90}= 13.27 µg/ml). The in vivo efficacy of *C. viminalis* extract (SAUDPC=11.5%) was comparable to that of maneb (SAUDPC=7.3%). These results show that *C. viminalis* and *S. aromaticum* extracts could be exploited in the management of late blight due to their antifungal properties.

[PS1-3] Evaluation of the best extraction solvent for *Tithonia diversifolia* biocide for effective pest management

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Aqueous, ethanolic, and ethereal solutions of *Tithonia diversifolia* leaf extracts of the same concentration were separately tested against *Periplanata americana* to evaluate the efficacy of the extracts within contact period of sixty minutes. The efficacies of the extracts on the experimental insect pest were measured in terms of percentage mortality within the period. The result showed that all the extracts were fatal to the insect pest. However, the aqueous extract had a very good efficacy causing percentage mortality of 82 % followed by ethanolic extract with 63%, ethereal extract with 45 % and the control (pure distilled water) with 0%. The study therefore concludes that, *Tithonia diversifolia* biocide can best be extracted using water rather than organic solvents for it to be developed into effective environmentally friendly, commercially viable and safe botanical insecticide.

[PS1-4] Sustainable management of pests of green cabbage, *Brassica oleraceae* var. *capitata* L. (Brassicaceae), using homemade extracts from garlic and hot pepper

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Cabbage, *Brassica oleraceae* var. *capitata* L., is an important leafy vegetable that provides vitamins and minerals for healthy body development. However, insect pests attack is a key contributing factor to its low yield. An experiment was undertaken at CSIR-Crops Research Institute's Agricultural Research field, Kwadaso in Ghana during the major seasons of 2010 and 2011 to explore the potential of homemade extracts from garlic, *Allium sativum* L. and hot pepper, *Capsicum frutescens* L. in the management of insect pests of cabbage. Emamectin benzoate (ATTACK®) and Lambda cyhalothrin (BOSSMATE® 2.5EC) were used as reference insecticides. There were ten treatments made up of three levels (10, 20 and 30g/L of water) each of garlic, pepper, a mixture of garlic and pepper, ATTACK®, BOSSMATE® and control (tap water). Among the insect pests recorded were *Brevicoryne brassicae* (L.), *Plutella xylostella* L., *Hellula undalis* F., *Phyllotreta* spp. and *Bemisia tabaci* (Genn.). Generally, the efficacy of garlic and pepper was comparable to that of ATTACK® and BOSSMATE®. Pepper (20g/L of water) and ATTACK® (1ml/L of water) were more effective in controlling *P. xylostella* than the other treatments. Natural enemies' encountered included ladybirds, spiders and hoverflies. Generally, BOSSMATE® caused the greatest reduction in natural enemies' abundance, followed by ATTACK®, with the plant extracts having mild effect on the natural enemies. Cabbage head yield was comparable among insecticide-treated plots and botanical plots. Garlic and pepper offer significant potential for further exploration and development into affordable plant protection products for cabbage pests' management, especially in smallholder farms and backyard gardens.

[PS1-5] Effects of botanical insecticides on the egg parasitoid *Trichogramma cacoeciae* Marchal (Hym. Trichogrammatidae).

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Laboratory studies were carried to investigate the side effects on *Trichogramma cacoeciae* of two formulated products of each of two botanical insecticides: Azadirachtine (Neemazal T/S Blank and Celaflor®) and Quassin (alcoholic or water extracts). The results showed that by exposing adults *T. cacoeciae* to residues of Neemazal formulations on glass plates, the tested preparations were either harmful (Neemazal-Blank) or moderately harmful (Celaflor). The two Quassin formulations tested were harmless. When treated host eggs were offered to adults *T. cacoeciae*, all tested chemicals were almost harmless. In a further test, host eggs parasitized at different time intervals (1-8 days), were sprayed at the same day. The results indicated that only Neemazal T/S-Blank formulation was slightly to moderately harmful reducing adult emergence.

[PS1-6] Characterization of the repellent, irritant and toxic effect of 20 essential oils on the whitefly *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae)

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Bemisia tabaci, vector of the tomato leaf curl virus, is a serious problem in tomato production in many parts of the world. The need to reduce the use of pesticide brings up the issue of finding natural alternatives to chemicals often ineffective and unsustainable because of resistance and pollution. The objective of this study was to evaluate the repellent, irritant and toxic effects of 20 essential oils on *B. tabaci* adults in laboratory. The repellent effect due to volatiles compounds was evaluated with a still-air olfactometer. The irritant effect was evaluated with a choice test in tube and was illustrated by a different cross rate between an essential oil treated net and a solvent treated net. The toxicity effect was evaluated with a no-choice assay in tube. The toxicity was quantified by the mortality after 24h of B. tabaci which crossed an essential oil treated net. Nets were dipped in essential oils at concentrations of 0.01%, 0.1% and 1%. The most promising essential oils were *Cymbopogon citratus*, *C. winterianus*, *Cinnamomum zeylanicum* and *Cuminum cyminum*. Responses varied according to oil type and dose. The three effects were dose dependent. The use of repellent essential oils for protecting vegetables against whiteflies is discussed.

[PS1-7] Pesticidal plants for the control of field and stored insect pests in the southern highlands of Tanzania

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Research work on pesticidal plants in the Southern Highlands of Tanzania began since mid-eighties at ARI-Uyole. The work started by collection of various plant materials from farmers who believed that they were effective for pest control. The materials were tested for efficacy at the station and those which showed potency for incest pest control were retained for further research at both on station and on farm. Some of the plants which proved to be effective are: Tephrosia vogelii, Vernonia amygdalina, *Azadirachta indica*, *Neuratanenia mitis*, *Gnidia kraussiana*, *Zanha africana* and *Tanacetum cineraiaiefolium*. Preparation and application methods were designed such that farmers could prepare at their local condition and easily apply. Of these plants some are naturally occurring in the bush some introduced and one is commercially produced. Plant part with pesticidal activity varies from one plant to the other in some it is the leaves e.g. *T. vogelii, V. amygdalina* and *A. indica*, those which the tuber is the source of pesticidal component are *N. mitis* and *G. kraussiana*. The barks of roots are a source the pesticide of *Z. africana* (a tree found in Miombo woodlands). For pythethrum (*T. cineraiaiefolium*) it is the dried flowers. Different methods of preparations were designed depending on the mode of application. Solutions from plant extracts were for field application and dry form mainly for storage pest and some for maize stalk borer control applied on whorl. Insect pests controlled by these pesticidal plants are; maize stalk borer (*Busseola fusca*), bean stem maggots (*Ophiomyia spencerella* and *O. phaseolus*, bean aphids (*Aphis fabae*), bean foliage beetle (*Ootheca benningseni*).

[PS1-8] Soil organic amendments reduce root-knot nematode infestations in tomato (*Lycopersicon esculentum* Mill) in Tanzania

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Tomato (*Lycopersicon esculentum* Mill) is an important food and household income generating crop for smallholder farmers in Tanzania. Dry season grown tomato is limited by various factors such as water scarcity, pest and diseases. Root-knot parasitic nematodes reduce tomato fruit yields. The objective of this study was to evaluate the problem of parasitic root-knot nematodes caused by Meloidogyne spp. and interventions of their control using organic amendments into soil. Tomato var. Tanya was grown on nematode heavily infested soil which has been under continuous tomato-Brinjal growing. The soil amendments were; (i) Goat manure, (ii) Cow manure, (iii) Flue-cured tobacco leave residues, (iv) Bat manure, (v) NPK fertilizer. Interviews with farmers gave additional information on tomato based crop rotation practices. Incidences of tomato plants infection with root-knot nematode were assessed using the Nomograph of root-knot galling index (1-10) and the rating scheme for evaluation of root-knot infestation. Results of the study show that application of organic manures reduced both incidences and the severity of root-knot nematodes on tomato plants. Incidences of nematodes decreased in the order of; NPK (41.5%) > cow manure (29.1%) > flue-cured tobacco leave residues (1.1%) > goat manure (0.2%) > bat manure (0.0%).The Galling indices of tomato plant roots followed the same pattern. There are interacting factors that leads to increased root-knot nematode build up into the soils. Based on this study integrated approaches for controlling root-knot nematodes for smallholder farmers should be developed in Tanzania

[PS1-9] Potential uses of Garneem for managing populations of whitefly on tomato production under open fields

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Whitefly (*Bemisia tabaci*, Homoptera: Aleyrodidae) is an economic pest in tomato production in South Africa. However, the excessive use synthetic chemical insecticides had since resulted in the development of resistance in this pest to a wide range of available insecticides on agrochemical markets. Fermented plant extracts of wild garlic (*Tulbaghia violacea*) and neem (*Azadirachta indica*) leaf had been code-named Garneem for use as sprays against insect pests. Field experiments were conducted to compare the effects of Garneem and chemical control on various stages of whiteflies in tomato production under open field conditions. Treatments were applied weekly for five weeks, with samples collected just prior to the next application. Relative to chemical control, Garneem consistently reduced eggs, larvae and adults, while there was no treatment effect on the pupae. In conclusion, Garneem could possibly be used to manage population densities of whiteflies in tomato production.

[PS1-10] A survey of plants with known pesticidal and medicinal values in Malawi: a case of Mkwinda and Malingunde extension planning areas in Lilongwe

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A survey was conducted to investigate plants known by indigenous people as having pesticidal and medicinal use in parts of Lilongwe in Malawi aimed at collecting and documenting botanicals locally available that are used to kill pests and cure diseases in plants, livestock and households. A total of 172 structured questionnaires were administered to households in different sections of Mkwinda and Malingunde agricultural extension planning areas (EPAs). Five focus groups discussions, comprising 20 to 30 community members each, were also conducted in the sections. Further questionnaires were administered to extension personnel in the sections. The results indicate that communities in Mkwinda and Malingunde EPAs experience pest and disease problems and have indigenous knowledge of plants with pesticide and medicinal values for plant, animal and household protection. Locally available botanicals, parts of the botanical used and the use of botanicals were identified including methods of preparing the botanicals. For example, *Markhamia obtusifolia* (Leguminosae) was used in households as a mosquito repellent while *Vernonia adoensis* (Compositae) and *V. amygdalina* were used to control vegetable insect pests, Newcastle disease in chickens and diarrhoea in humans. The limitations of using botanicals as perceived by the farming households in the study area are documented. It was concluded that pesticidal and medicinal plants exist in Lilongwe and therefore scientific investigation on these plants is required.

[PS1-11] Potential uses of indigenous *Cucumis africanus* and *Cucumis myriocarpus* as root-knot nematode-resistant rootstocks in watermelon (*Citrullus lanatus*) production

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Global withdrawal of synthetic fumigant nematicides like methyl bromide due to their eco-unfriendliness resulted in serious consequences in production of crops which do not have genotypes that are resistant to plant-parasitic nematodes. Watermelon (*Citrullus lanatus*) is one such crop, where infection by highly aggressive root-knot nematodes (*Meloidogyne* species) invariably results into as high as 50% yield loss, with occasional total crop failures. Initial screening for nematode resistance in *Cucumis* species indigenous to South Africa suggested the possibility of the existence of nematode resistance, with the probability of these species being compatible with *Citrullus* species in inter-generic grafting technology. This paper reviews the various empirical tests which led to the conclusion that indigenous wild watermelon (*Cucumis africanus*) and wild cucumber (*Cucumis myriocarpus*) have the potential for use as root-knot nematode-resistant rootstocks in watermelon production.

Posters Symposium 2 Postharvest

[PS2-1] An integrated strategy towards bruchid management in common beans: The effect of using tolerant/resistant variety and pesticidal plants in combination

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A study to investigate the effect of using plant botanicals to determine the shelf life of two common bean varieties in storage when subjected to two bruchid species was conducted at Chitedze Agricultural Research Station Crop Storage Laboratory in 2010. The specific objectives of the study were to establish the interaction effects between a resistant genotype and local control methods on storage life of beans as well as determine which indigenous bruchid control method in storage was more effective to protect beans from bruchid infestation. Two bean varieties (one resistant and the other susceptible) and six bruchid control methods (single treatments and their combination) were used against two bruchid species namely the Mexican bean weevil (*Zabrotes subfasciatus*) and common bean weevil (*Acanthoscelides obtectus*). Data were collected on number of F_1 progeny emerged (live and dead), adult weevil mortality, developmental period and number of perforated and unperforated seeds. The study showed that botanicals if timely applied can effectively protect beans from bruchid damage in storage. Bruchid control methods applied in combination other than single treatments were more effective. There was no evidence of interaction between a resistant bean variety and a bruchid control method to support the hypothesis that an inherent resistant variety used in combination with a bruchid control method provided extended storage period. Although laboratory investigations can provide useful indicators regarding efficacy of plant products it is essential that trials are also carried out in the farmers' fields to validate laboratory findings.

[PS2-2] Potentials of locally-available plant materials as protectants of kolanut against *Balanogastris kolae* Desbr. (Coleoptera: Curculionidae) infestation during storage in Nigeria

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The kolanut weevil, *Balanogastris kolae* (Desbr.) is the most damaging insect pest of kolanut during storage in Nigeria. It is a field to store pest and can cause severe yield loss between 30-70% in the store. The use of synthetic insecticides to control is usually discouraged due to environmental and health hazards. Besides, most farmers cannot afford the high cost of insecticides. In some rural kola-growing communities, locally available plant materials are used for protection of kolanut. These include *Citrus aurantifolia, Erythrophleum suaveolens, Leea procera, Jatropha curcas* among others. On the other hand, most kolanut traders apply chemical insecticides to store the nuts. This might not be unconnected with the ease of application, availability and affordability of the insecticides in retail measures. However, this has grave health implications since the nuts are usually consumed raw. Against this background, there is need to screen, formulate and package some of the locally available plant materials for their protectant action against *B. kolae* in storage. This paper attempts to appraise the potentials and utilization of botanicals for the control of *B. kolae* in Nigeria.

[PS2-3] The efficacy of some botanical insecticides against common bean bruchids, *Zabrotes subfasciatus* and *Acanthoscelides obtectus*

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Laboratory studies were carried out to investigate the effectiveness of nine botanical extracts in three formulations for the control of common bean bruchids, *Zabrotes subfasciatus* Boh and *Acanthoscelides obtectus* Say on common beans and to compare the performance of dust, water and oil extract formulations. From powder formulation, botanicals used were *Ocimum canum, Tagetes minuta, Eucalyptus globus, Ricinus communis* leaves and *Neorautanenia mitis* tuber were tested under laboratory condition. The effective of the extracts was compared with Actellic Super Dust (pirimiphos methyl + permethrin). *T. minuta* was the least effective botanical followed by *R. communis, O. canum* and *E. globus*, while *N. mitis* was the most effective. The mortality rate of weevils after 14 days was 100% as that of Actellic Super Dust. The results indicate that all the tested botanicals have potential for protecting bean seeds against infestation by bean weevils, but *N. mitis* is the most effective. Water extracts formulation of *O. canum, T. minuta, E. globus* and *R. communis* had lower efficacy compared to *N. mitis* and Actellic Super Dust which had performed better. Oil extracts of botanicals have shown higher efficacy on bean weevils as Actellic Supper Dust, and therefore have potential for protecting stored beans against infestations. The result from this study showed that *N. mitis* extract and oil extracts have higher efficacy as that of Actellic Super Dust on protecting common beans against common bean bruchids. All botanicals which have shown better results can be used efficiently as the recommended synthetic insecticides because botanicals have got several advantages that outlay their disadvantages. It is believed that botanical insecticides will minimize the undesirable side effects of synthetic insecticides and help to preserve the environment for future generations; also it is easily available and usable for cheap price also to peasants.

[PS2-4] Economic evaluation of optimised pest management options on bean cropping systems in Southern Africa

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In Malawi common bean (*Phaseolus vulgaris*) is important as a source of protein, micronutrients and essential vitamins, particularly for poor households. Bean yields are low, often <400 kg ha-1, largely attributable to insect pests and diseases. While new varieties have improved yields, increased productivity will happen with effective pest management over which farmers have some direct control. The study set out to establish baseline indicators against which the project impact would be measured. Using purposeful and simple random sampling techniques, a total of 150 bean farmers were sampled and interviewed. Multiple regression analyses were used to establish the relationship between bean yields and the amount of botanical insecticides used to control pests. Results indicated that many farmers (51%) did not use pest management options in their bean farming systems. Those that used pest management options identified: crop rotation, early ploughing, timely planting, timely weeding, industrial insecticides and botanical insecticides as possible options. Farmers, who are using the products, indicated that they lacked knowledge on the actual measurements accompanied by lack of plant materials to process the pesticides. Regression analyses results indicated that there was a negative relationship between amount of botanical pesticides applied and the resulting bean yield. Furthermore, there was a positive and significant relationship between education level of household heads and bean yield. This therefore calls for intense research on the processing and utilisation of pesticidal plant products and farmer education on the use of botanical pesticides to control pest.

[PS2-5] Investigation for dual pesticidal-antifungal natural product for pre- and postharvest control of maize weevils and aflatoxin producing fungi

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Maize is a vital food and feed grain worldwide. Aflatoxin and other mycotoxins produced primarily by the fungi *Aspergillus flavus* and *Aspergillus parasiticus*, and *Fusarium moniliforme*, respectively, are very potent carcinogens in both humans and livestock and can readily contaminate maize grain in the field and in storage. Stress on developing maize, particularly during reproductive growth, facilitates infection by the fungi, production of mycotoxins and contamination of the grain. Maize kernel breakage in the field or storage by insect pests facilitates the infection of maize grain by mycotoxin producing fungi. *Chenopodium ambrosioides* and *Tagetes minuta* are used traditionally in several parts of Tanzania for protection of stored cereals and legumes from insect pests. We have investigated the dual insecticidal-antifungal activity against maize grain borers and aflatoxins producing fungal species of a traditional stored maize protection product comprising of *Chenopodium ambrosioides* and *Tagetes minuta* extracts. Our findings show that, the combined Chenopodium ambrosioides and Tagetes minuta extract at 100µg/ml efficiently killed maize grain borers as well as completely inhibited the growth of aflatoxin producing fungal species in cultures. Our findings reveal the usefulness of the product on both food security and security and it deserves further scientific attention for the development of such green pesticides.

[PS2-6] Evaluation of pesticidal plants effectiveness in maize and cowpea storage in Zambia

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Pests have been found to pose one of the greatest challenges to food security. Pesticidal plants have been used by African farmers for generations and are of particular importance to poor, small-scale farmers for effective, low-cost pest control on field crops, stored products and livestock. A better scientific understanding of how these plants work and where they grow will optimise their sustainable use. A research was conducted in Choma Zambia to evaluate effectiveness of four pesticidal plants in controlling a wide range of pests in storage of maize and cow peas especially maize weevils and bruchids. Data collection on effectiveness of the pesticidal plants was undertaken first at farmer level using a participatory monitoring system by six farmer groups. Samples were also collected on a monthly basis for 32 weeks. All the plant materials were effective for 16 weeks. In maize storage *Securidaca longepedunculata* treatments (2% and 5%) had less than 10% damage up to 24 weeks after which all treatments were not effective. In cowpeas pest control lasted for only eight weeks for most treatments. *Cissus quandrangularis* and *Bobgunnia madagascariensis* were effective until week 16 and 32 respectively. The study showed that although all the pesticidal plants used had some pesticidal activity, *Securidaca* and *Bobgunnia* were the most effective.

Posters Symposium 3 Farming systems, veterinary and general

[PS3-1] Farmers' ethno-botanical knowledge of termiticidal plant uses in Zambia

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A survey was carried out on ethno-botanical knowledge of termiticidal plants in Chongwe District, Lusaka province, Muswishi area, Central province, and several districts in Southern province of Zambia. The methods used in collecting the data included Focused Group discussion, questionnaires and transect walks among small-holders fields. The study revealed that five plant species in Chongwe district, four plant species in Muswishi district, Central province, and fourteen plants from Southern province were believed to contain putative termiticidal toxicity. The most widely used termiticidal plants in all the study areas were *Tephrosia vogelii* Hook., *Bobgunnia madascariensis* Desv and *Euphorbia tirucalli* L. The study has shown that indigenous knowledge of termiticidal plants is a novel component that can become part of the integrated pest management (IPM) strategy for resource poor farmers. Putative termiticidal properties of selected plants are discussed. Popularization and commercialization of these ethno-botanical termiticides can help increase food security in Zambia.

[PS3-2] Acaricidal effect of the essential oil of *Erigeron floribundus* leaves on ticks (*Rhipicephalus lunulatus*) of West African Dwarf goat

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Acaricidal properties of the essential oil of *Erigeron floribundus* leaves was investigated on *Rhipicephalus lunulatus*. Four doses of oil (0.00; 0.02; 0.025; 0.03 µl/g) were used in vitro. Each replication consisted of 10 ticks in a petri dish with filter paper impregnated uniformly with the essential oil at the bottom. The results of this study indicate that, essential oil of *E. floribundus* leaves is toxic to *R. lunulatus*. After eight days of exposure, the highest dose (0.03 µl/g) of the essential oil had exterminated 80% of ticks and the lowest dose (0.02 µl/g) 13.33%. No mortality was observed in the control petri dish. The LD_{50} of the essential oil on the second day of exposure was 1.33 µl/cm² indicating a relatively low toxicity of this product on this parasite.

[PS3-3] Use of *Crotalaria* species in cropping systems as nematode antagonistic plants: A review

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Crotalaria spp. are one of the important African indigenous vegetables (AIVs) whose young leaves and shoots are consumed and contributes 100% of the daily dietary requirement for vitamin A, vitamin C, iron calcium and 40% of proteins when 100g of the fresh weight are consumed. It has medicinal applications and has been reported to have several agronomic advantages. Crotalaria spp. have nematicidal and nematistatic compounds that make them poor host to many plant-parasitic nematodes including *Meloidogyne* spp., *Heterodera glycines*, *Belonolaimus longicaudatus*, *Rotylenchulus reniformis* and *Radopholus similis*. Much of the research on Crotalaria has focused on nematode suppression in agricultural production systems. Many AIVs like *Solanum* spp., *Cleome* spp. and *Amaranthus* spp. are susceptible to nematode attack. *Crotalaria* spp. can be used in farms not only as vegetables but also as nematode suppressive crops. Crotalaria spp. can be used as cover crops, green manure for soil amendment, trap crops, rotation crops or they can be intercropped with the nematode susceptible AIVs. The objectives of this review are to summarize the knowledge of the efficacy of Crotalaria spp. as plant-parasitic nematode antagonistic plants, the mechanisms of nematode suppression and outline the prospects for using this crop effectively.

[PS3-4] Effects of antifungal plant extracts on some selected physiological parameters of French beans (*Phaseolus vulgaris*)

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Rust (*Uromyces appendiculatus*) is a major foliar disease that reduces yields and pod quality in beans. The field trial of French beans was established at Jomo Kenyatta University of Agriculture and Technology (JKUAT) in a randomized complete block design replicated 4 times. The plots were 3 × 4 m with 0.5 m paths between plots and 1.5 m between blocks. Variety Amy was planted at a spacing of 30 × 10 cm within and between rows. During the growing period, beans were infected with rust from natural inoculum at the field. Three antifungal plants belonging to different genera were selected from native flora of Eastern, Western and Rift Valley provinces in Kenya. Physiological responses such Transpiration (E), Stomatal conductance (gs), and Photosynthetic rate (Pn) of French beans treatments were examined using Infrared gas analyser (IRGA) in all treatments. *M. volkensii* treatment caused an increase in the rate of transpiration of the bean plants, which resulted in loss of water. *M. volkensii* had positive effects on enhancing the rate of photosynthesis in bean plants.

[PS3-5] The phytochemistry in improving the health of populations.

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Different plants in Africa are used in folk medicine to treat many diseases. A long the time they have been of interest to researchers because of their wide range of traditional uses. Phytochemical and pharmacological investigations various on extracts : crude extracts, hexane, EtOAc, MeOH extracts and isolated products show that scientists are holding the domain in their hands to improve folk health or to fight against various epidemics. Such works comprise the isolation of products using different sorts of chromatography, structure elucidation using 1D and 2D NMR and biological test activities. In most of cases, it has been demonstrated clearly that plant extracts and some isolates possess very interesting biological activities and are utilized as medicine or baseline for manufacturing medicines affordable by populations.

[PS3-6] Climate change and variability: Experience, coping and adaptation strategies among smallholder organic farmers of Central Kenya

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The study to assess smallholder organic farmers' experience, coping and adaptation strategies to climate change and variability (CCV) was conducted in Kajiado, Kiambu and Murang'a counties of central Kenya. 63 certified organic farmers were interviewed using a semi- structured questionnaire. Experience on CCV was depicted in terms of rising air temperatures (68%), reducing rainfalls (75%), droughts and seasonal fluctuations (50%). Information on CCV was acquired through personal experience (26%) and from both the print and electronic media (69%). Among the leading causes of CCV cited were; emission of greenhouse gases into the atmosphere (34%), deforestation and poor agricultural practices (64%). The most profound effect of climate change was reduced crop yields (85%). Crop failure resulting from drought and flooding of crop fields were reported by 15% of farmers. Farmers were using both scientific (74%) and traditional (23%) methods of weather forecasting. The farmers reported that, employing the use of decision support tools alongside modern methods of weather forecasting provide a better alternative to the traditional weather forecasting methods, hence, better preparedness to combat the effects of CCV. Most (95%) farmers' responded to the effects of CCV through; growing of drought resistant crops, mulching, application of organic inputs, agroforestry, rain water harvesting and use of innovative organic farming techniques. The farmers contended that through trainings and exposure, they will be empowered to cope with and reverse the negative impacts of CCV and consequently guarantee food and nutritional security.

[PS3-7] Vermicomposting of Pressmud and Water Hyacinth (*Eichhorniae crassipes*) by the earthworm *Perionyx excavates* (Perrier E)

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Vermicomposting is the technique of using earthworms in the disposal/degradation of organic wastes. The worm cast/vermicompost obtained is a better source of organic manure than other aerobically or anaerobically degraded compost, and is very environmental friendly unlike chemical fertilizers. Pressmud, an organic waste/by-product from sugar cane processing is an environmental pollutant as it is often dumped around factory units, occupying space besides its foul smell. It is however rich in plant nutrients especially nitrogen (N) and phosphorus (P). Water hyacinth (*Eichhornia crassipes*), is the most predominant, persistent and troublesome aquatic weed in the tropics. It causes enormous water loss through evapotranspiration besides being a public nuisance - destroying recreational and aesthetic values of water bodies. It also forms breeding ground for obnoxious insects like mosquitoes and hinders photosynthetic processes of submerged aquatic plants. The weed is however very rich in potassium (K). Thus a combination of pressmud and water hyacinth forms a good source of plant macronutrients NPK. This study thus aimed at vermicomposting these industrial and environmental wastes by the fast growing composting worm, *Perionyx excavatus* and estimating the selected macronutrients. Equal amounts (by weight) of these organic substrates were mixed in cement cisterns (32 × 27 × 7cm).Adult worms were introduced in one cistern, while the other cistern without worms served as control. The set-ups were monitored and maintained at a temperature of 25± 2^0C and 75%moisture content for 25 days. The selected plant macronutrients: nitrogen, phosphorus and potassium in the substrate, compost and vermicompost were determined and the values compared ($P< 0.05$). The vermicompost had 47% more nitrogen, 60% more phosphorus and 40% more potassium than the compost

Posters Symposium 4 Biopesticide technologies

[PS4-1] *Beauveria bassiana* 5653 could be an alternative to synthetic insecticides against *Plutella xylostella* in Togo

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An evaluation of the potential use of the entomopathogen *Beauveria bassiana* 5653 in the biological control of the major pest of the cabbage *Plutella xylostella* was carried out from 2007 to 2008 in Togo. The experiments were conducted in station and on farm, in the littoral ecosystem. The results revealed that the formulation of B. bassiana 5653 reduces significantly the density of *P. xylostella* populations. It thus, made it possible to increase the yield of 57% on farm, compared to the control. In contrast, the synthetic insecticides Conquest Plus 388 EC.(16 g acetamipride, 300 g triazophos and 72 g cypermethrin) and Decis 25 EC.(25 g deltamethrin) used as references gave densities of P. xylostella and yields comparable with the control. This indicates that *P. xylostella* was not sensible to the synthetic insecticides. The use of the bio insecticide *B. bassiana* 5653 can thus be an alternative for the management of the non-sensitive strain of *P. xylostella* in Togo.

[PS4-2] Using computer-based model to determine a bio-nematicide dosage for use in botinemagation

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Botinemagation is the use of botanicals through irrigation water for suppressing plant-parasitic nematodes. Fermented crude extracts (FCE) from fruit of wild watermelon (*Cucumis africanus*) are used in botinemagation to manage the root-knot (*Meloidogyne* spp.) nematodes in large commercial farming systems. In FCE form, the materials are highly nematicidal. However, they are also highly phytotoxic to the crops being protected against nematodes. The objective of this study was to present a computer-based model used in quantifying tomato plant-stimulating diluted dosages of FCE for use through irrigation systems. Nematode-infested plants are grown under a series of diluted dosages of FCE, weekly applied for 56 days. Variables are subjected to analysis of variance. Significant plant variables are subjected to a Curve-fitting Allelochemical Dosage Response (CARD) computer-based model, which generates six biological indices. The threshold stimulation and saturation point indices of different organs are used to compute the mean dosage stimulation range. The model had been successfully used to quantify diluted dosages and to determine application intervals for the test materials on various crops.

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[PS5-1] Use of ethnobotanical data in the search for and identification of potential drug plants: A case study of *Ocimum* and *Plectranthus* species (Labiatae) in Kenya.

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Traditional medicine has utilized plants to palliate, cure and/or prevent diseases in both humans and animals. The acquisition of knowledge has been through trial and error, and observation. Today, the search for botanical drugs with potential for killing pests throughout the world has increased the need for accurate means of identifying plants with possible effective pharmacological and biological activity. This paper discusses the value of ethno-botanical data in the preliminary search for potential drug plants using the case of *Ocimum* and *Plectranthus* species in Kenya.

[PS5-2] Optimised pest management with Tephrosia on legume cropping systems in Malawi: A baseline study

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In Malawi common bean (*Phaseolus vulgaris*) is important as a source of protein, micronutrients and essential vitamins, particularly for poor households. Bean yields are low, often <400 kg ha-1, largely attributable to insect pests and diseases. While new varieties have improved yields, increased productivity will happen with effective pest management over which farmers have some direct control. The study set out to establish baseline indicators against which the project impact will be measured. Using purposeful and simple random sampling techniques, a total of 150 bean farmers were sampled and interviewed. Multiple regression analyses were used to establish the relationship between bean yields and the amount of botanical insecticides used to control pests. Results indicated that many farmers (51%) did not use pest management options in their bean farming systems. Those that used pest management options identified: crop rotation, early ploughing, timely planting, timely weeding, industrial insecticides and botanical insecticides as possible options. Farmers, who are using the products, indicated that they lacked knowledge on the actual measurements accompanied by lack of plant materials to process the pesticides. Regression analyses results indicated that there was a negative relationship between amount of botanical pesticides applied and the resulting bean yield. Furthermore, there was a positive and significant relationship between education level of household heads and bean yield. This therefore calls for intense research on the processing and utilisation of pesticidal plant products and farmer education on the use of botanical pesticides to control pest.

[PS5- 3] Citi Entrepreneurs

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Ensuring farming communities in Tharaka District are fully empowered to develop plant-based seed and seedling supply enterprises affords an opportunity to ensure appropriate supply of plant material as well as contributing to improved household incomes. Data from tree seedling demand figures against current market supply for Tharaka North District will be presented.

[PS5-4] COLEACP-PIP - A European cooperation programme for the ACP horticultural industry

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COLEACP PIP is a European cooperation program for the ACP horticultural industry. A second phase of PIP was launched in October 2009 for a period of 5 years, funded by the European Development Fund and managed by COLEACP, the association for ACP (African-Caribbean-Pacific) exporters and EU importers of horticultural produce. Its objectives are 1) Responding to concerns of European consumers; 2) Contributing to sustainable and safe food; 3) Towards minimal pesticide residues. At an operational level, COLEACP-PIP collaborates with other organizations (e.g. FAO) to increase efficiency and maximize impact. Contact pip@coleacp.org for more information.

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- Rootgard: Biological, microbiopesticide made from naturally occurring microorganisms for control of soil and root diseases including fusarium, rhizoctonia, pythium, caterpillars, Diamond Back Moth, botrytis, enhancement of nutrient availability and growth promotion.
- PL Plus: Biological control of nematodes (eggs, nymphs and adults).
- Pyegar: A combination of natural pyrethrins and garlic extract in assorted vegetable oils. Effectively controls all stages of destructive spider mites. Controls aphids, thrips, caterpillars, whiteflies and scales. Pyegar is synergized by vegetable oils. It does not contain piperonyl butoxide, a synthentic synergizer used in most other pyrethrum formulations.
- Fosphite: Formulated from potassium and phosphorous salts and thus it has good source of potassium and phosphorous. Controls mildews, blights, leafspot, pythium, fusarium, rhizoctonia, sclerotia, dumping off, crown rot, root rot and rust.
- GC-3: Botanical for the control powdery mildew, leaf spots.
- Clean start: Biological pack, containing four products (Rootgard, Humax, Phosgard and Natural wet). Protects seedlings against fusarium, bacterial wilt and stimulates seed germination.
- Humax: Soil conditioning agent, improves soil structure and enhances nutrient up take.

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Awards Ceremony

The African Academy of Sciences (AAS) hosts the World Academy of Sciences-Regional Office for sub-Saharan Africa (TWAS-ROSSA). In this capacity AAS coordinates the activities of TWAS and its affiliated organisations in the region. This includes enhancing the visibility of TWAS among young and promising scientists, identifying eminent scientists in the region and nominating them for TWAS membership and awards and networking amongst its members.

Public Lectures

One of the ways in which the visibility of TWAS is enhanced is by organising Meetings, Conferences, symposia and public lectures on issues related to sscience, technology and sustainable economic development for both the scientific community and the public.

Awards and Prizes

AAS has annually identified and nominated scientists, especially young scientists, in the region for various awards and prizes. These include the *TWAS Regional Prize* and the *TWAS-ROSSA Young Scientists' Prize*. Nominations for these prizes are reviewed by Committees comprising AAS and TWAS fellows in the region.

TWAS Regional Prize

The TWAS Regional Prize rotates around three thematic areas namely *Public Understanding of Science/Science Communication*; *Development of School Science Curricula/ Development of Scientific Educational Material* and *Building Scientific Institutions*. There is no age limit under this prize. The prize includes a cash award of US$ 3,000 and a prize certificate.

TWAS-ROSSA Prize for Young Scientists

The *TWAS Regional Office Young Scientists' Prize/TWAS-ROSSA Prize for Young Scientists* is given in either Basic Sciences or Applied Sciences. It honors scientists under the age of 45 who have made outstanding contribution in science in either field. It is expected that by recognizing their achievements, the scientists and their institutions will be encouraged to promote scientific research and strive to excel in their endeavors. The Prize winner receives a cash prize of US$ 3,000 and an award certificate.

The 2012 Prize Winners

The winner of the 2012 TWAS-ROSSA Young Scientists Prize is Dr. Emmanuel Iyayi Unuabonah. The 2012 prize in *Applied Sciences* was intended for a young scientist from sub-Saharan Africa whose research application has had significant technological impact and that offered innovative solutions to Africa's challenges.

Dr. Unuabonah receives the prize for his research into low cost water treatment that is aimed at improving water quality in the region. His area of research is focused on the remediation of water and wastewater through the use of low-cost materials with the ultimate goal of improving water quality and reducing the incidence of water-borne diseases in urban and rural communities in Nigeria and Africa. One of his most exciting findings is the hybrid material he recently prepared from locally sourced kaolinite clay and Carica papaya seeds both of which are present in abundant quantities in Nigeria. This hybrid material was found to have very unique capacity to reduce even very low concentrations of micropollutants (heavy metal ions, PAHs, PCBs, and BTEX) to the g/L limit (trace limits) which were found to be below the WHO safe limits for the presence of these micropollutants in solution. Moreso, the preparation of the hybrid material was economical and eco-friendly; far cheaper than commercial ion-exchange resins currently used in treatment of water. This novel hybrid material has shown complimentary properties to those of kaolinite clay and Carica papaya seeds in removing micropollutants from wastewater with unusual physical and chemical properties. Dr. Unuabonah is a Senior Lecturer at Redeemer's University in Nigeria.

Prof. Charles Obadiah N. Wambebe is the recipient of the 2012 TWAS Regional Prize on *Building Scientific Institutions.* Prof. Wambebe, also a Fellow of AAS, is Founder-President of the International Biomedical Research Institute, Nigeria. He has both developed and strengthened about ten reputable national and international institutions in the area of drug discovery and development. From 1989 to 2001, Wambebe was the director-general of the National Institute for Pharmaceutical Research and Development (NIPRD) based in Abuja, Nigeria, which was recognized in 2000 as a WHO Collaborating Centre. Recently, NIPRD has been accorded Centre of Excellence by the African Network for Drugs and Diagnostics Innovation in Health Innovation in Africa. In 2011, NIPRD entered into a Memorandum of Agreement with the University of Minnesota, USA, the University of Strathclyde, Glasgow, UK, and the National Agency for Drug Administration and Control, Nigeria. This award was announced during the 23rd General Meeting of TWAS held in Tianjin, China from 18th to 21st September 2012 together with the announcement of the winners from the other TWAS regional offices inthe world.

Prof Charles Wambebe, FAS, FAAS, FTWAS, FPSN, FWCPHARM, OFR
President and CEO, International Biomedical Research in Africa, Abuja, Nigeria

The African Academy of Sciences wishes to honour Professor Charles Wambebe for his services to science in Africa. Charles Wambebe and his colleague, Ebi Kimanani (deceased), launched the Product Research and Development for Africa (PRADA) in 2005. WHO/TDR domesticated PRADA while Wambebe served as its Chair. Later, PRADA metamorphosed into the African Network for Drugs and Diagnostic Innovation (ANDI). In 2001, Wambebe envisioned the International Biomedical Research in Africa (IBRIA) and invited his younger colleagues (Kimanani and Gamaniel) as Co-Founders. The mission of IBRIA is to reduce the burden of diseases and conducts clinical trials of existing and emerging medical interventions. IBRIA is registered in Nigeria, South Africa, Kenya and Uganda. In 2005, Wambebe was appointed the Pioneer Pro-Chancellor and Chairman of Council of Bingham University, Nigeria. In this capacity, Wambebe was responsible for the academic, management and financial oversight functions of the new University. Bingham University has since been accredited by the National University Commission to run various undergraduate courses including Human Medicine. Wambebe served as Pioneer Director-General/CEO of NIPRD(1989-2001). The purpose of NIPRD was to bridge the gap in drug development and production and pharmaceutical research for policy. Building human resource was his top priority. He recruited young Nigerians and engaged retired Professors to mentor them. Staff were motivated by the existence of conducive research and development environment, unique conditions of service, participation at conferences, skill acquisition workshops, dedicated mentorship programmes, publications and post-graduate programmes abroad. Wambebe won UNDP ($1.7 million) and Japanese Government ($3.5 million) grants for the establishment of multi-purpose pilot plant and the purchase of research equipment, respectively. A drug manufacturing facility (NIPCO) was established. NIPRD was accorded the status of WHO Collaborating Centre and Centre of Excellence by ANDI. In 2012, Wambebe established the Agape Medical Centre in Uganda which is involved in medical missions, health research and clinical services.

Dr. Emmanuel I. Unuabonah
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The African Academy of Sciences wishes to honour Professor Charles Wambebe for his services to science in Africa. A new *s*ulphonated *a*niline-modified *p*olyvinyl alcohol/*K*-feldspar (SAPK) composite was prepared. The cation exchange capacity of the composite is five times that of neat feldspar with specific surface area and point of zero charge also significantly increased from 15.56 ± 0.1 m^2/g and 2.20 (K-feldspar) to 73.6 ± 0.3 m^2/g and 1.91 (SAPK) upon modification. The adsorption of Zn^{2+}, Cd^{2+}, and Pb^{2+} adsorption onto SAPK was largely independent of pH with higher adsorption rate compared with neat feldspar. This particularly applies to the initial adsorption rates. The adsorption process involves both film and pore diffusion; film diffusion initially controls the adsorption. Adsorption on neat feldspar is best fitted with a Langmuir model, indicating the formation of adsorbate monolayers. Both pure feldspar and SAPK show better selectivity for Pb^{2+} than for Cd^{2+} or Zn^{2+}. Another new composite of kaolinite clay and *Carica papaya* seeds with improved cation exchange capacity (CEC), rate of heavy metal ion uptake and adsorption capacity for heavy metal ions was prepared. The CEC of the new material (HYCA) reaches ca. 75 meq/100g but showed an unexpectedly low surface area (≈10 m^2/g). The average particle size of the material decreased from over 200 μm to 100 μm. The composite material is a highly efficient adsorbent for heavy metals especially at very low concentrations were most adsorbents are inefficient. Starting from an initial metal concentration of 1 mg/L, the new adsorbent reduces the Cd^{2+}, Ni^{2+}, and Pb^{2+} concentration in aqueous solution to ≤ 4, ≤ 7, and ≤ 20 μg/L, respectively, from the first minute to over 300 minutes using a fixed bed containing 2 g of adsorbent and a flow rate of ≈ 7 mL/min. Approximately 99% of the material can be regenerated with 0.1 M HCl making it a cheap and highly efficient alternative to activated carbon for water treatment.

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