

20th Workshop On

Sustainable Horticultural Production in the Tropics

Special Topic:

"Methods to analyze the effects of climate change on plant growth - The Use of R Statistical Software"

> December 1st – 4th, 2020 Virtual via KENET / BigBlueButton

PROGRAM & ABSTRACTS

Organized by: HORTICULTURAL ASSOCIATION OF KENYA In Conjunction With: PWANI UNIVERSITY, KENYA & INSTITUTE OF HORTICULTURAL PRODUCTION SYSTEMS, LEIBNIZ UNIVERSITÄT HANNOVER, GERMANY

> Sponsored by: German Academic Exchange Service (DAAD), Germany





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ACKNOWLEDGEMENT

The organizing committee wishes to thank Leibniz Universität Hannover, Germany for supporting the workshop and DAAD for sponsoring the workshop.





CHAIRPERSON'S REMARKS



Welcome to the 20th Workshop on Sustainable Horticultural Production in the Tropics. The workshop has a special focus on 'Methods to analyze the effects of climate change on plant growth - The Use of R Statistical Software' that will focus on training on research in Horticulture. Systems analysis refers to "a general methodology that applies a holistic perspective by taking all aspects of the situation into account, and by

concentrating on the interactions between its different elements". This approach provides a superior way of analysing problems and formulating research. The principles of systems and case studies will be covered in dedicated sessions during the workshop. During the workshop, 38 presentations will be made. The presentations will cover crop protection and production, plant nutrition and management, Plant breeding and molecular techniques, Post-harvest handling and quality, socio-economic and environmental issues in horticultural production. The issues embrace the entire value chain and will provide a wider and deeper understanding of the importance of the key players in the development of the sector. I congratulate all the presenters for preparing the abstracts and encourage them to submit full papers for publication in the HAK journal 'African Journal of Horticultural Sciences'.

It's noteworthy that almost a third of the presentations will be by postgraduate students. This will contribute to capacity building and ensure sustainability of HAK and the horticulture sector. On this note, I wish to appeal to all stakeholders to continue supporting postgraduate students and indeed young scientists. You may join an initiative started by HAK executive led by Dr. Lucy K. Murungi to contribute to a kitty for honoring outstanding young scientists.

The workshop takes place virtually owing to the new normal of holding conferences occasioned by the COVID 19 Pandemic. During this year's Workshop we will miss our traditional two day visit schedules. However we will resume with physical meetings once the pandemic is controlled.

This workshop aims at bringing horticultural consumers, producers, students, private and public advisors including professors, mentors and researchers together, thus facilitating establishment and further development of a stakeholders' forum. The knowledge and information gained will undoubtedly contribute to cohesiveness and transformation of the horticultural sub sector.

A lot of time and effort has gone into the organization of this workshop. I sincerely thank the organizers including Horticultural Association of Kenya (HAK) officials, and Pwani University for making arrangements for the Students pre-workshop training. We





are grateful for financial and technical support from the German Academic Exchange Service (DAAD) through our collaborators from Hannover led by Prof. H. Stuetzel. To all the workshop participants, thank you for taking time from your busy schedules to attend this workshop virtually. I hope that you will find the workshop presentations and discussions inspiring.

You are most welcome and God bless you.

Amisaka

Chairperson Horticultural Association of Kenya



l l Leibniz t o 2 Universität t o 4 Hannover

	PROGRAMME OF THE WORKSHOP		
November 30 2020 - Pre-workshop Student's training on the use of R Statistical software			
Time (HRS)	Topic/Activity	Presenter/ Facilitator	
09:00 -10.30	R- the basics	Kigathi R/Kioko M	
10:30-11.30	Data exploration	Kioko M/ Kigathi R	
11.30-11.45	HEALTH BREAK		
11.45-1300	Data analysis regressions	Kioko/Kigathi/Bönecke	
13.00-14.00	LUNCH BREAK		
14.00-17.00	Data analysis regressions	Bönecke/Kioko/ Kigathi	
December 1 st ,	2020; Day 1		
Official openin	g and Keynote speech		
Chairperson:	Dr. J. Mwafaida		
Time	Topic/Activity	Presenter/Facilitator	
09.00-09.30	Opening Ceremony	Mbaka J, HAK	
00.00.10.17		Chairperson	
09.30-10.15	Keynote Topic : Climate change and plant	Diane Saunders	
	hreeding		
10.15-10.30	HEALTH BREAK		
	Session 1: Crop Protection and Plant Breedi	ing	
	-	0	
Time	Chairperson: Prof. Moritz Knoche	Due contou / Eo cilitatou	
10 20 10 50	lopic/Activity	Presenter/Facilitator	
10.30-10.50	Genetic characterization of the linger millet blast	de villers S , Devos K, Dida M. Tesfave K	
	pathogen, mughupi the oryzae in eastern Annea	Alemu T. Takan I. Ringo	
		J, Khan CH,	
		Sreenivasaprasad S,	
		Masaki DKH and	
10 50 11 20	The finance millet blast nother an Magnanewith	Mulama J Magabi III, Khang Cil	
10.50-11.20	arvzae modulates PWI 1 and PWI 2 effector genes	de Villiers S Oi P	
	to infect weeping lovegrass and <i>Sporobolus</i>	Mbinda W and Devos K	
	<i>phyllotrichus</i> as alternative hosts.		
11.20-11.40	Mining next-generation genome sequencing data	Mulama JA, DevosKM,	
	for genetic diversity assessment of eastern Africa	Qi P, Hashim S and de	
11 40 12 20	finger millet blast fungus	Villiers S	
11.40-12.20	in Kenva	R Stomeo F Were MN	
	ni Kenya	Joyce N3 and Torrance,	
		L	
12.20-12.40	Molecular identification of bacterial isolates from	Muwawa EM, Makonde	
	the rhizospheres of four mangrove species in Kenya	HM, Jefwa JMKahindi	
12 40 12 00	Effort of Didomil@ application regime in late blight	JHP and Khasa DP	
12.40-13.00	(<i>Phytophthora infestans</i>) management on vield and	and Ovoo I	
	nesticide residue in notato tubers		





13.00-14.00	LUNCH BREAK	
14.00-16.00	Student Session (Analysis of Plant Growth Using R	Kigathi R/Kioko M
	software)	
December 2 nd ,	2020; Day 2	
	Session 2: Agronomy	
	Chairperson: Dr. Andreas Fricke	
Time	Topic/Activity	Presenter/ Facilitator
09.00-09.40	Key note: Climate change on Plant Growth	Stuetzel H
10.00-10.20	Effects Of Biocontrol Agents On Germination And	Mathenge PW
	Growth Rate Of Tomatoes	
10.20-10.40	Effects of chicken manure, chicken manure tea and	Barmao V , Wangari G,
	cabbage	J Wanjiku
10.40-11.00	Effects of varying shading regimes on total	Samwel K., Kamunya
	monomeric anthocyanins in purple tea (Camellia	S., Kiplimo J., Mule S.
	Sinensis (L.) O. Kuntze)	
11.00-11.20	HEALTH BREAK	T
11.20-11.40	Evaluation of selected hydroponic media on growth and yield of spinach (<i>Spinacia oleracea</i>)	Chepkemoi Mercy
11.40-12.00	Commercial Arbuscular Mycorrhizal Fungi (AMF)	Mwaura O and Kigathi
	and rhizobia improve growth of <i>Vigna radiata</i> L.	R
12.00-12.20	Dual Output Per Horticultural Unit Area: Combining	Wanjiku J, Marx P,
	Horticultural Crops With Agri-Photovoltaic Shading	Maghenda M, Kettner S,
		Kambura AK, Feistel U,
		Mcharo M, Mwololo B
		and Ebermann J
12.20-12.40	Effects of Nitrogen and Phosphorus Fertilizer	Kimutai Langat*, Peter
	Application on Yield and Quality of Purple Tea	Opala, Samson
	(<i>Camellia Sinensis</i> (L) <i>O. Kuntze</i>) in Nandi and	Kamunya, Simon
12 40-13 00	The Effect Of Dodder (Cuscuta Spn) On Growth And	Monica Vego and
12.40-13.00	Quality Of Six Tea Clones In A Green House	Fvelvne Cheramgoi
13.00-14.00	LUNCH BREAK/POSTERS	
	Session 3: Cron Protection and Plant Breedi	inσ
	Chairperson: Dr. Lucy K. Murungi	
Time	Topic/Activity	Presenter/Facilitator
14.00-14.20	Bio-fumigant formulations in biodegradable filter	Matu F
	bags for the management of root-knot nematodes	
	(<i>Meloidogyne</i> spp) in tomato	
14.20-14.40	Efficacy of Purpureocillium lilacinum and	Gatwiri KJ
	<i>Trichoderma trianum</i> in control of root-knot	
	nematode (<i>Meloidogyne</i> spp.) in eggplant	
14.40-15.00	Domestication of indigenous edible mushrooms	Ukoko M , Mwafaida J
	collected from Kaya Univara forest, Kilifi County	and Kanindi J
December 3 rd ,	2020; Day 3	





Session 4: Postharvest Handling and Quality Chairperson: Prof Hartmut Stützel		
Time	Topic/Activity	Presenter/ Facilitator
09.00-10.00	Key note: Climate-smart postharvest technologies	Ambuko J
	to reduce food loss and waste in horticultural value	
	chains: Case study Of 'Zero Loss' Centres	
10.00-10.20	Investigation Of Steaming Processing Technology	Kariuki P
	On Biochemical Properties Of Purple Tea (<i>Camellia Sinensis</i>)	Owaga E and Muchiri MN
10.20-10.40	Effects of multiple rounds of infusions on the	Ochanda SO, Mwangi
	quantities of quality parameters in brewed green,	SK, Ruto HK, Owuor PO
	black and purple teas	
10.40-11.00	Evaluating The Efficacy Of Edible Plant Extracts On	Andanje Quinter,
	Shelf Life Of Mango (<i>Mangifera Indica</i>) And Tomato	Kamotho Grace
	(Lycopersicon Esculentum)	
11.00-11.20	HEALTH BREAK	
11.20-11.40	A Colorimetric Probe For Detection Of Gibberellic	Aoko L. I, Ondigo D. A,
	Acid Exudated By Ralstonia Solanacearum In	Kavoo A. M, Wainaina
11 40 12 00	Tomato	C.M, and Kiirika L.M
11.40-12.00	Evaluation of catecnins content of second	S Ochanda SO Wycliffo
	varieties	W and Kinlimo I
12.00-12.20	Effect Of Plucking Standards On Clonal Tea	Esther E. Avwa: P.
	(<i>Camellia Sinensis</i>) Selenium And Aluminium Levels	Okinda O and Ochanda
		SO.
12.20-14.00	LUNCH BREAK	
14.00 -	HAK AGM	HAK Officials
17.00	December 4th 2020, Dev 4	
	December 4 th , 2020; Day 4	•
	Session 5: Crop Protection and Plant Breed	ing
Time	Topic/Activity	Presenter/Facilitator
09.00-9.20	Repellency potential of tomato herbivore induced	Muthoni R
	volatiles to the greenhouse whitefly, <i>Trialeurodes</i>	
	vaporariorum	
09.20-9.40	The effect of the aqueous crude extracts of <i>Tithonia</i>	Cheruiyot R, Nchore S
	diversifolia (Hemsley) and Zingiber officinale	and Mwafaida J
	(Roscoe) in suppressing Fusarium oxysporum in-	
	vitro	· · · · · · · ·
09.40-10.00	Fungal Endophytes - The Prospect Of Bio-Control	Kipngetich TE, Kiplimo
10.00.1020	Agents In Crop Protection	JJ, Matasyon J
10.00-1020	vegetable production in Kenven urban conters	Mwafaida I
10 20-10 40		iniwalalua J
10.20-10.40		
Session 6: Socio-economic and Environmental Issues		
Chairperson: Prof. John Wesonga		





Time	Topic/Activity	Presenter/Facilitator	
10.40-11.00	In vitro antibacterial and antifungal activities of tea	Ruto HK, Ochanda SO,	
	seed oil against E. coli, S. aureus, C. albicans, C.	Yugi JO and Bii CC	
11 00 11 20	neoformans & 1. mentagrophytes		
11.00-11.20	County: A Case Study Of Karatina Ward	GUIIIIJI B	
11.20-11.40	Perception And Adoption Level Of Urban	E.N. Ovaro, I. B.	
	Horticulture Technologies, Nairobi County, Kenya	Mukundi and R. Mbeche	
11.40-12.00	The seed Cotton industry in Kenya: Problems, prospects and revival strategies	Auma EO and Ngode L	
12.00-12.20	Antimicrobial Properties Of Specialty Tea Extracts	Kipsura EJ., Koech RK.,	
	From Different Tea Camellia Sinensis Cultivars On	Ochanda SO., Kamunya	
	Selected Pathogenic Bacteria And Fungi	SK., Koech J., Bii, CC.	
12.20-12.40	Perenialization Of Annual Vegetables: A Path	Kere GM and MA	
	Towards Food Security And Sustainable Ecological	Otiende	
40.40.40.00	Services		
12.40-13.00	Determinants of Credit Access Among Smallholder	wadeya Lennox	
	Dan y Farmers in Kinangop Sub-County, Kenya.	Obel-Gor Otiende MA	
13.00-14.00	LUNCH BREAK		
	SECTION TWO; POSTER PRESENTATION		
	SESSION 7 (a); POST HARVEST HANDLING AND QUALITY		
14.00-14.20	Characterization Of Microorganisms In Made Black	Cherotich M, Ochanda	
	Cut Tear And Curl (CTC) From Selected Factories	SO, Ochola L, Ogote H	
14.20-14.40	Influence of harvest practices, packaging and	Muchui MN, Kipkemei	
	transportation management strategies on	M, Njoroge E, Ndungu	
	postharvest losses of tomato in Kenya	BN and Mac-donald B	
	SESSION 7 (b); SOCIO-ECONOMIC AND ENVIE	RONMENTAL ISSUES	
14.40-15.00	Poster session		





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ward Error! Bookmark not	defined.





IRISH BLESSINGS





1.) May the road rise to meet you May the wind be always in your back May the sun shine warm upon your face And the rain fall soft upon your field

> And until we meet again May God hold you in the hollow of his hand And until we meet again May God hold you in the hollow of his hand

2.) May you have the road you walk Downhill all the way to your door Have warm words on a cold evening And a full moon on a dark night

> And until we meet again May God hold you in the hollow of his hand And until we meet again May God hold you in the hollow of his hand

3.) May you have food and raiment And a soft pillow for your head May you be forty years in heaven Before the devil knows that you are dead

> And until we meet again May God hold you in the hollow of his hand And until we meet again May God hold you in the hollow of his hand

4.) Until we meet again God, I hope will bless you day and night May the Lord keep you in his hand And never close his fist too tight

> And until we meet again May God hold you in the hollow of his hand And until we meet again May God hold you in the hollow of his h





KEYNOTE ADDRESS ONE

KEYNOTE TOPIC 1: Climate Change and Plant Diseases: Methods of Surveillance and Plant Breeding

The wheat-rust conflict: Shifty enemies and the long reach of genomics

Diane G.O. Saunders¹

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Wheat rusts have been associated with crop failures and famine throughout history. Recent outbreaks of yellow (stripe) and stem rust in Europe have been linked to expansions in pathogen geographic distribution, exotic incursions and increased virulence. Our rapid "field pathogenomics" strategy, that uses transcriptome sequencing of infected wheat leaves taken directly from the field, has enabled us to gain insight into the population structure of the yellow rust pathogen over successive seasons and track the recent re-emergence of wheat stem rust in western Europe. Furthermore, we showed that a lack of resistance to stem rust in modern European wheat varieties, increased presence of the alternate host barberry, alongside changes in climatic conditions could be brewing the perfect storm for stem rust resurgence in Western Europe. Building on our "field pathogenomics" strategy we also recently developed a portable, genomics-based, point-of-care approach that utilizes the nanopore sequencer and is specifically tailored for identifying individual strains of the wheat yellow rust pathogen. This new method called Mobile And Real-time PLant disEase (MARPLE) diagnostics enables rapid identification of both newly emergent strains and those with specific properties such as fungicide resistance. Through trials of the methodology in Ethiopia, we have shown that it is capable of generating results within just 48 hours of field sampling. This new strategy has the potential to revolutionise plant disease diagnostics, changing how plant health threats are identified and tracked into the future.

Key words: Disease diagnostics, rust, strains, pathogenomics, plant health





SECTION ONE: ABSTRACTS OF ORAL PRESENTATIONS

1.1 CROP PROTECTION AND PLANT BREEDING

Genetic characterization of the finger millet blast pathogen, *Magnaporthe oryzae* in eastern Africa

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Abstract

Finger millet is mainly grown by subsistence farmers and is an important food security crop but its productivity in eastern Africa is limited to as little as one sixth of its potential (400 to 2000 kg/ha) mainly due to blast disease, caused by *Magnaporthe oryzae*. Due to the susceptibility of the predominantly cultivated landraces and cultivars, this disease has been identified as the major production challenge in the region. A study was conducted to collect and characterize the finger millet blast genome to help determine its distribution, virulence and genetic diversity. More than





500 blast samples were collected in 2016 and 2017 from Ethiopia, Kenya, Tanzania and Uganda. From these, 224 representative monoconidial isolates were purified, and supplemented with 30 additional "historical isolates" collected from 2000 to 2002. A reference genome was generated from isolate E2 and the other isolates were resequenced by whole genome sequencing. Genetic diversity analyses were conducted using STRUCTURE, Principal Coordinate Analysis and Phylogenetics and revealed two main groups that roughly correlated with the country of origin, with isolates from Ethiopia and Tanzania clustering together and those from Kenya and Uganda forming the other group. Blast virulence and specificity was investigated by infection of a diverse panel of 8 finger millet varieties with a representative subset of 25 isolates. From these, 4 isolates were selected for a genome-wide association study (GWAS) with a population of 180 diverse finger millet accessions to determine the genomic basis for tolerance to blast disease, which is ongoing. These new genomics tools for both finger millet and the blast fungus that infects it will allow breeders to develop improved high-yielding resilient finger millet varieties for eastern Africa and beyond.

Key words: Eleusine coracana, finger millet blast, whole genome sequencing

The finger millet blast pathogen *Magnaporthe oryzae* modulates *PWL1* and *PWL2* effector genes to infect weeping lovegrass and *Sporobolus phyllotrichus* as alternative hosts.

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Abstract

A study was conducted to determine the role of PWL genes in the pathogenicity of the finger millet blast fungus *Magnaporthe oryzae*, population structure of finger millet blast isolates Blast disease and investigate the distribution of *PWL* in 223 *Eleusine* blast isolates collected from four eastern African countries by amplifying the coding sequence to determine the presence and absence of these two genes. *PWL1* and *PWL2* genes were cloned from *Eleusine* isolate E22 and transformed separately into *Eleusine*





isolate U34, which do not have either of the genes, using *Agrobacterium tumefaciens*. Subsequent infection assays on weeping lovegrass showed that all transformants harboring *PWL1* and/or *PWL2* lost pathogenicity on weeping lovegrass but remained infective on finger millet. Furthermore, the presence or absence of *PWL1* and *PWL2* grouped the 223 *Eleusine* isolates into two distinct classes, FMB-1 and FMB-2. The former did not have *PWL1* or *PWL2*. FMB-1 isolates that were tested in infections assays were highly virulent on both finger millet and weeping lovegrass. FMB-2 isolates contained either *PWL1* or *PWL2* or both and isolates from this group that were tested in infection assays did not infect weeping lovegrass but were highly virulent on finger millet, indicating that the avirulence of FMB-2 isolates on weeping lovegrass was determined by the presence of *PWL1* and/or *PWL2*. The loss and gain of *AVR* genes might be an important mechanism underlying the rapid evolution of *Eleusine* isolates virulence towards alternative hosts.

Key words: PWL genes, Magnaporthe oryzae, FMB-1, FMB-2, weeping lovegrass.

Mining next-generation genome sequencing data for genetic diversity assessment of eastern Africa finger millet blast fungus

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Abstract

Finger millet is a key staple crop in eastern Africa cultivated mainly by small-holder farmers. Typically, it yields only one-third of its genetic potential of 6 tons per hectare due to the use of unimproved varieties that are regularly affected by the finger millet blast disease along with other stresses. The main aim of this research was to assess the





genetic diversity within a collection of 226 eastern Africa finger millet blast fungus isolates, a key staple crop in eastern Africa, using next-generation sequencing data. To address this, 226 blast isolates from Kenya, Tanzania, Uganda and Ethiopia, were previously sequenced using Illumina technology. One of these isolates, E2, was sequenced using a combination of PacBio and Illumina technologies and used to generate a reference genome assembly for finger millet blast. The sequenced reads from the other 225 isolates were mapped to it. The study reported here investigated the genetic diversity of this collection and used the sequence data for variant calling, which identified 174,300 SNPs. Cluster analysis was then conducted using STRUCTURE, principal component analysis (PCA) and maximum-likelihood phylogenetic inference. The results indicated that in eastern Africa, finger millet blast isolates grouped into two main populations with sub-population structures and the isolates did not cluster according to the countries of origin. Isolates from Ethiopia and Tanzania grouped together but formed a different cluster from the Ugandan and Kenyan isolates, which formed a separate group. There was a clear correlation between isolates' clustering patterns and the latitude north or south of the equator from where they were collected. The clustering pattern suggested that finger millet blast diversity may be influenced by climatic conditions such as the amount of rainfall, humidity and altitude of a region. This new information will enhance the existing knowledge of the genetic diversity of the blast fungus and contribute to the development of effective control strategies against the pathogen, especially in finger millet.

Key words: Genome sequencing, diversity, finger millet, blast fungus, East Africa

Viruses infecting groundnuts (Arachis hypogaea L.) in Kenya

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Abstract

Apart from providing food, animal feed and cash, groundnuts are important components of farming systems as they improve soil fertility. In Kenya, current yields are well below optimal potential and important constraints include the devastating impact of high incidences of pests and diseases particularly viruses spread by insect vectors which cause approximately 80% of damage. About 31 viruses from 14 genera have been found infecting groundnuts naturally worldwide. Among these, Groundnut rosette assistor virus (GRAV), Groundnut rosette virus (GRV), satellite RNA associated with GRV and/or GRAV (rosette complex), Peanut mottle virus (PeMoV) and Cucumber mosaic virus (CMV) are economically important in SSA. Recent diagnostic surveys in Kenya have not elucidated much the viruses infecting the crop. A study was conducted to identify virus diseases of groundnut in the main producing areas of Kenya. In October 2016 and May 2017, two diagnostic surveys were conducted in 6 major groundnut growing counties of Western Kenya. Leaf samples showing virus-like symptoms were collected and analysed either by serology and /or next generation sequencing (NGS). In total, 103 groundnut farms were visited and 315 samples, collected. Of these, 261, were ELISA positive for one or more viruses tested. Fourteen viruses (CABYV, CABMV, CMV, CPMMV, BYMV, GRSV, CCYV, BCMNV, BGMV, PeMoV, SPCFV, BCMV, CPMV and MCMV), were detected by ELISA while nine (GRAV, satellite RNA associated with GRV and/or GRAV, CPPV1, CPPV2, CpCSV, PBMYV, SPCFV, BCMNV and PeMoV) were detected by NGS. Most plants had mixed infections of more than one virus. The most common viruses detected by ELISA were CABYV, PeMoV, CMV, CPMMV, BCMNV and BYMV. Of all the viruses detected in Kenyan groundnut fields only Cowpea aphidborne mosaic virus (CABMV), CMV, PeMoV, and CPMMV are transmitted through **groundnut** seed, therefore, further studies needed to determine how many more virus are transmitted through this route.

Key words: Ground nuts, diseases, gene sequencing, viruses, region

Molecular identification of bacterial isolates from the rhizospheres of four mangrove species from Mida creek and Gazi bay, in Kenya

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Abstract

Mangrove ecosystems provide a unique ecological niche for diverse microbial communities, however the phylogenetic and functional description of microbial diversity in the mangrove ecosystems have not been adequately addressed to the same extent as that of terrestrial environments. This study was therefore aimed at identifying bacterial isolates from the rhizospheres of four mangrove species (Sonneratia alba, Rhizophora mucronata, Ceriops tagal and Avicennia marina) using the 16S rRNA gene analysis approach. Rhizospheric sediment samples of the mangroves were collected from Mida creek and Gazi bay, Kenya, using standard protocols. A total of 36 representative bacterial isolates were analyzed. The isolates were characterized using morphological and molecular characters. Pure gDNA was extracted from the isolates, polymerase chain reaction amplified and sequenced. The 16S rRNA gene sequences were BLASTN analyzed against the Genbank database, the closest taxonomically related bacterial sequences were retrieved and used for phylogenetic analysis using MEGA X software. Morphologically, the isolates differed in their cultural characteristic concerning color, shape, margin, elevation and gram reaction. Phylogenetic analysis classified the isolates into five genera, namely Bacillus, Pseudomonas, Micrococcus, Microbacterium and Streptomyces that belong to three different phyla (Firmicutes, Proteobacteria and Actinobacteria). The findings show that the underexplored tropical mangrove rhizospheres harbor useful diverse bacteria that have been implicated in secondary metabolites production such as antimicrobials and enzymes and also contributing in ecological and biogeochemical processes through nutrient cycling. Further analysis of the bioactive compound production potential of the isolates will give more insights into the types of bioactive compounds produced and their biotechnological potential.

Keywords: 16S rRNA gene sequence, Rhizosphere, Mangrove sediments, Marine bacteria, biotechnology.





Effect of Ridomil[®] application regime in late blight (*Phytophthora infestans*) management on yield and pesticide residue in potato tubers

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Abstract

Late blight caused by *Phytophthora infestans*, is one the most important disease of potato with a potential of causing up to 100% yield loss depending on weather conditions. The disease is managed majorly using chemical fungicides which are applied between 5 to 7 days intervals resulting in 10 to 15 applications times within cropping season. This extensive use of chemical fungicides has raised human health and environmental concerns. Ridomil[®] (Metalaxyl 4% + Mancozeb 64%) is one of the most extensively used preventive and curative fungicide to manage late blight in Kenya. The objective of the study was to determine the effect of Ridomil[®] application regime on yield and metalaxyl residue in potato. A field trial was conducted at Kenya Agricultural and Livestock Research Organization (KALRO) Tigoni where Ridomil® was applied at 7, 14 and 21 day spray intervals at a rate of 2.5 g L^{-1} (Manufacturer's recommended rate). The treatments were laid in randomized complete block design with five replications. Further, fresh tuber samples were randomly collected from Limuru and Wakulima markets of Kiambu and Nairobi counties respectively. Assay of the pesticide residues (metalaxyl) were analyzed using a gas chromatography (GC) equipment. Data on disease severity (RAUDPC), incidence and yield were collected and analyzed using SAS software. Treatment means were separated using Tukeys Honest significance difference. Higher tuber yield and lower disease score were obtained in plots sprayed at an interval 7 days compared to unprotected plots. Samples collected from Limuru market and plots sprayed at 14 7 and day spray interval had 0.09, 1.69 and 0.08 mg Kg⁻¹ respectively. Metalaxyl residues observed in samples from Wakulima market and plots sprayed at 21 day spray interval were below the limit of detection. The results indicate that potato consumed in most parts of Kenya could be unsafe following application of Ridomil® at weekly and biweekly interval.

Key words: Ridomil®, Residue, Application interval, Soxhlet, Metalaxyl





Bio-fumigant formulations in biodegradable filter bags for the management of root-knot nematodes (*Meloidogyne spp*) in tomato.

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Abstract

Root-knot nematode (*Meloidogyne spp*) have reduced greenhouse tomato production in Kenya by about 20%. Farmers manage RKNs using synthetic nematicides that are toxic to the users and the environment. The objective of this study was to evaluate the efficacy of organic amendments loaded in filter bags for the control of RKNs in tomato. Two asteraceous agronomic weeds, Mexican marigold (Tagetes minuta) and Mexican sunflower (*Tithonia diversifolia*) were formulated in powder and pellet forms and dispensed in biodegradable filter bags or directly. Their effectiveness was evaluated against RKN's population and on tomato yield. The experiment was conducted in a curative and preventive mode, with the roots and leaves being evaluated individually. Results showed that the amendments greatly suppressed Meloidogyne incognita. Treatments with powders of T. minuta roots (79%) and T. diversifolia leaves (78%) greatly reduced juvenile populations followed by pellets of T. minuta. Leaves (74%), T. diversifolia roots (72%), and Bionematon® (70%) compared to the control. All treatments increased fruit Yield. Fruit yield increased by 4-0.5% for the curative mode as compared to the preventive. Powder amendments (79%) reduced RKN populations better than pellets (73%) while pellets increased yield (62%) than powder (50%). These findings show that formulations of Tagetes minuta and Tithonia diversifolia can serve as an alternative to nematicides and also reduce the use of conventional fertilizers, especially in organic farming.

Keywords: Biofumigants, filter bags, juvenile population, Meloidogyne incognita, Tagetes minuta, Tithonia diversifolia





Efficacy of *Purpureocillium lilacinum* and *Trichoderma triunum* in control of root-knot nematode (*Meloidogyne spp.*) in eggplant

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Abstract

Plant- parasitic nematodes, in particular *Meloidogyne* species, cause significant yield reduction in commercial eggplant production. The efficacy of Trichoderma triunum and *Purpureocillium lilacinum* in reducing root knot nematode natural population as well as reducing disease incidence and severity was tested in this study. Their performance was compared to that of Oxamyl, a synthetic nematicide, already in the market. The study was inspired by the current trend in agriculture that vouches for use of bio pesticides and bio fertilizers. Eggplant was selected due to its commercial nature of production in the country for export market. With nematodes being a major pest, most farms and farmers rely on synthetic nematicides to control them. These nematicides however, pose a risk to human health through high residual levels in food crops or by volatilization thus contaminating the air. They also risk being washed into waterways thus contaminating them. Therefore, these risks as well as a general demand for pesticide residues far below the legal maximum residual levels (MRLs) has led to the popularity of bio pesticides. The objectives were; to determine the efficacy of Trichoderma trianum and Purpureocillium lilacinum in the control of root knot nematode population. To determine the effect of Trichoderma triunum and *Purpureocillium lilacinum* on the performance of plant growth parameters. The project was carried out in the University greenhouse laid in the complete randomized design (CRD). Four treatments were used; Trichoderma triunum, Purpureocillium lilacinum, Oxamyl and control. The treatments were replicated four times each. The plants were raised from certified seeds in pots. The two bio controls successfully colonized the plant roots endophytically. As a result the plants treated with the bio controls showed a significant performance in growth (18.35c and 17.11b) than the chemical control (14.21b). The pots that were not treated with any nematicide exhibited stunted growth (9.37) and leaf chlorosis. The performance of both Trichoderma triunum and Purpure ocillium lilacinum would be attributed to their ability as good rhizosphere competitors. In conclusion the bio controls successfully colonized the rhizosphere giving the plants a competitive advantage over the nematodes. The chemical control





was also effective in the control of the nematodes but too much use of chemicals is toxic to the ecosystem. However, failure to control the nematodes at all leads to losses. From the study I would recommend the use of bio- controls in the control of nematodes. I would also recommend studies to determine the efficacy of the bio controls as fertilizers.

Key words; Trichoderma triunum, Purpureocillium lilacinum, root knot nematode, eggplant

Domestication of indigenous edible mushrooms collected from kaya Chivara forest, Kilifi County

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Abstract

Kaya forests are pockets of natural rainforests in the coastal regions of Kenya that are considered to be an intrinsic source of ritual power and cultural identity of the Mijikenda community. For generations, these forests have sustained communities settled around the forests with food and fuelwood. Mushrooms have seasonally been harvested from these forests, but the harvests have dwindled with time because of population pressure, overharvesting of fuelwood, and frequent disturbance on the breeding grounds. Harvesting wild edible mushrooms require skills and experiences to distinguish edible from poisonous species. These communities have inherent skills to identify edible mushrooms, but sadly these skills are a preserve of the older generation. The youth are engaged in modern-day technologies, and there is a danger of losing important ethnobotanical technologies with the aging society. This study, therefore, intended to document techniques used to identify edible indigenous mushrooms and collect them for domestication and commercial production. Experienced elders from Kaya Chivara were enlisted to guide the team in mushroom identification and collection. Purposeful sampling was adopted where edible mushrooms were collected from the Eastern side of the forest under the canopy of Brachystegia speciformis. Mushrooms having damages from insect and rodent bites, those with soft clean caps without powdery spores, non-latex producing mushrooms, and those that do not irritate the skin nor sting when tongue-tested were considered edible. Images at all possible angles were taken in situ before collecting the





mushroom samples for further identification using google images. GPS positions of all collection sites were recorded, and the soils sampled. Eighteen edible indigenous mushroom samples were collected. These include Mwasi (6 samples), Hako ra nyani (6 samples) Choga sikiro rehure (2 samples), Mbwate (1sample) Choga rerema (1sample), Mhama (1sample), Unknown (1sample). All edible mushrooms were sampled. Using Google image blast and literature matching, the 18 samples were classified into 6 species and partially identified as *Agaricus spp, Pleurotus spp, Emetic spp*, and *Rusulla spp*. Currently the 6 partially identified species are on domestication trials to produce spawn for controlled production before molecular and toxicological analyses are done. Commercializing these species is the ultimate goal of this study.

Key words: Indigenous edible mushrooms, Kaya-Chivara,

Repellency potential of tomato herbivore induced volatiles to the greenhouse whitefly, *Trialeurodes vaporariorum*

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Abstract

The greenhouse whitefly, *Trialeurode vaporariorum* (Hemiptera: Aleyrodidae) (Westwood) is among key pests of tomato (*Solanum lycopersicum L.*,) in sub-Saharan Africa. To understand the interaction between the pest and the plant's herbivore induced volatiles, this study investigated the response of four tomato cultivars (kilele F1, assila F1, red beauty F1 and nemonneta F1) upon infestation by the pest. The behavioural response of *T. vaporariorum* to infested and uninfested tomato plants of these cultivars was studied using a Y-tube olfactometer bioassay. Plant volatiles were analyzed using gas chromatography-mass spectrometry (GC-MS). Insects were attracted to uninfested plants of all the four tomato cultivars. However, infested cultivars of kilele F1 (P = 0.001) and red beauty F1 (P = 0.001) were unattractive to *T. vaporariorum*. GC-MS analyses of collected tomato volatiles identified 26 compounds from the four cultivars that were either uninfested or infested. Each compound was tested individually against clean air at three different concentrations (0.01%, 0.1% and 1%). Similarly, these compounds were assayed, in combination with an un-infested cultivar red beauty F1 in one arm versus un-infested tomato cultivar red beauty F1 in





the other arm. Out of the tested compounds 1, 8-cineole was found repellent when tested in combination with red beauty F1 in all the three concentrations. Moreover, *T. vaporariorum* was repelled by p-cymene at 0.1, 1% and limonene at 1% concentrations when tested in combination with red beauty F1. This study demonstrated that 1, 8-cineole, p-cymene and limonene were repellent to *T. vaporariorum* in a laboratory study.

Key words: HIPV's, Tomato, cultivars, volatiles, pests, Olfactometer, GC-MS

The effect of aqueous crude extracts of *Tithonian diversifolia* (Hemsley) and *Zingiber officinale* (Roscoe) in suppressing *Fusarium* oxysporum invitro

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<u>Corresponding author: danielomwoyo@yahoo.com</u> Abstract

Tomato (Solanum lycopersicum L.) is a major vegetable crop in Kenya. Its production potential is greatly constrained by Fusarium oxysporum f.sp. lycopersici (Sacc.). Despite the use of resistant cultivars and other cultural control strategies, there are sustainability challenges while the performance of biological control agents is inconsistent. There are also health concerns posed by use of synthetic pesticides. Application of natural plant products that promote vigorous growth and health of plants products is a new frontier to control Fusarium wilt disease. In this study, the effect of aqueous crude extracts from *Tithonia diversifolia* (Hemsley) and *Zingiber* officinale (Roscoe) to suppress the growth of Fusarium oxysporum in-vitro was investigated. Crude extracts from leaves and flowers of T. divesifolia and Z. officinale were obtained by soaking homogenized plant materials overnight at 4°C in sterile distilled water at a ratio 1:1 (wt/vol.). The minimum inhibition concentrations of these extracts were determined using the poisoned food technique (Sumalan et al., 2019) where various concentrations of these extracts were tested against F. oxysporum on Potato Dextrose Agar. Finally, a complete randomized design with seven treatments and four replications was adopted to test for efficacy. Data on fungal suppression distances (mm) and minimum inhibitory concentrations (mg/ml) were collected and





subjected to one-way analysis of variance using SAS and Students-New-Keuls Test (SNKT) at p< 0.05 to separate the means. The combinations of *Zingiber officinale* at 100mg/ml and *Tithonia diversifolia* leaf at 150 mg/ml had significant inhibition at 79.6% which was at par with a fungicide Score[®] (Difenoconozale) that was used as a positive control at 79.8%. The performance of these two concentrations was significant compared to the SDW negative controls. However, extracts from *Tithonia* flower had the least inhibitory effect at 0.9% when applied at 200mg/ml. These result suggests that extracts from *Tithonia* leaves and rhizomes of *Zingiber officinale* are potential suppressants against *Fusarium oxysporum*. Further investigations to ascertain efficacy in the field are in progress.

Key words: Fusarium wilt, ginger, Tithonia

Fungal endophytes -the prospect of bio-control agents in crop protection

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Abstract

Fungal endophytes are regarded as inexhaustible sources of pharmaceuticals and agrochemicals with profound antibacterial, anticancer or antifungal activities. Diaporthe sp, an endophytic fungus residing in medicinal plant S. cordatum, showed good antagonism against bacterial pathogens of beans; Pseudomonas syringae pv phaseolicola (sp) and Xanthomonas axonopodis pv phaseoli (Xap), with zones of inhibitions of 14.00 \pm 1.15 mm and 17.00 \pm 0.58 mm against the test organisms respectively. Fermentation of *Diaporthe sp* was performed on rice media followed by ultrasonic extraction with methanol to yield crude methanol extract. The extract was partitioned with hexane and ethyl acetate to yield their respective crude extracts. Ethyl acetate fraction of *Diaporthe sp* yielded one **new naphthalene** derivative compound which was accorded IUPAC name as 3-methoxy-5-methylnaphthalene-1, 7-diol. The compound displayed palpable antibacterial activities against Psp and Xap, with corresponding Minimum Inhibitory Concentration (MIC) values of 2.50 mg/ml (7.00 \pm 0.00 mm) and 1.25 mg/ml (7.67 \pm 0.33 mm) against the tests organisms respectively. These slight MIC values are chiefly attributed to the presence of active secondary metabolites in the fungal extracts that act against the test pathogens. This has therefore





confirmed that fungal endophytes and their extracts have desirable antibacterial activities hence can be used in the formulation of agrochemicals or used as bio-control agents in crop protection of common beans (*Phaseolus vulgaris* L).

Key words: Endophytes, 3-methoxy-5-methylnaphthalene-1, 7-diol, Diaporthe sp, Bean bacterial pathogens

Assessment of irrigation water used for vegetable production in Kenyan urban centres

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Abstract

Market production of vegetables in some major cities in Africa has utilized contaminated water for irrigation. Microbial loads accumulated by vegetables grown under such conditions are rarely considered when designing public health policies. However, most crops have inherent survival mechanisms to filter-off microbes. The question is, are these mechanisms adequate for public safety consumption? This study determined the microbial filter-off ability of Brassica oleracea, Spinacea oleracea, Solanum nigrum, and Amaranthus hybridus by assessing the bacterial load in the leaves. Seedlings grown under sterile conditions were planted in pots in a greenhouse and irrigated with sewage, borehole, tap, and sterile distilled water as a control. Treatments were replicated four times in a randomized block design. Leaves were harvested and evaluated for total coliforms using Nutrient agar for 60 days. The bacterial load (cfu/ml) in the irrigation water was estimated at 6.2×10^8 for sewage, 2.1 $x10^8$ for borehole, and 1.5 $x10^8$ for tap water. The initial bacterial load at day 20 when irrigated with sewage water was 2.4 $\times 10^8$ for S. olerecia, 2.3 $\times 10^8$ for A. hybridus, 1.9 $x10^8$ for *B. olerecia*, and $1x10^8$ for *S. nigrum*. The bacterial load increased more than 100 fold at day 40 and leveled at 3.41×10^8 for S. oleracea, 2.7 $\times 10^8$ for B. oleracea at day 60. However, bacterial load in A. hybridus and S. nigrum increased more than 100 fold at day 40 but significantly reduced to 1.22×10^8 and 0.74×10^8 at 60, respectively. Some traces of bacteria were also noticed when the vegetables were cooked at 60-100°C for 20 min, indicating the presence of mesophilic and hyperthermophilic bacteria. However, cooking significantly (P=0.05) reduced bacterial loads. These results indicate that contaminated irrigation water transfers bacteria from the field to the table, and the dose may be potent even after cooking. Solanum nigrum remains the most efficient of the tested vegetable in filtering off bacteria in contaminated irrigation





water. These results indicate that the quality of irrigation water is important in vegetable production.

Key words: Bacterial load, Vegetables, Irrigation, Foodborne diseases

1.2 AGRONOMY

Effects of biocontrol agents on germination and growth rate of tomatoes

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Abstract

Studies have indicated that the use of synthetic chemical compounds to improve plant germination and growth rate results to production of produce that contains chemical residues. Consumption of such food is harmful and poses health risks to consumers. The research objective was to determine the effect of biocontrol agents on germination and growth rate of tomatoes. Experiments were done in Karatina University farm under a greenhouse. The experimental design used was completely randomized design (CRD). There were seven treatments which included: Azospirillum, Rhizobium, Mycorrhiza, Bacillus megaterium, Master Mix (compatible mixture of Azospirillum, Rhizobium and Mycorrhiza), Moringa seed oil and Camelia sinensis seed oil. The study entailed priming the tomato seeds (variety Rio Grande) with biocontrol agents prior to sowing and germination. Data on stem length, leaf emergence and germination rate was collected. Data on leaf emergence was collected by counting the number of leaves per representative plant per treatment. Data was analyzed using Genstat software package version 14. Means were separated using Fischer least significant difference (LSD, p < p0.5). There was a significant difference in stem length, leaf production and seed germination rate among the treatments. Moringa seed oil and Azospirillum had the best performance with 98% and 96% respectively on germination. The study confirmed the potency of the biocontrol agents in improving tomato crop performance in terms of germination, growth and production of safe produce free from synthetic chemical compound residues. The experiment forms an important basis on knowledge of effect of





the tested bio-control agents on tomato crop performance. Further research on effect of biocontrol agents on yields of tomatoes is recommended.

Key words: Biocontrol agents, germination, growth, tomato

Effects of chicken manure, chicken manure tea and synthetic fertilizer (NPK) on growth and yield of cabbage

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Abstract

Application of chicken manure and chicken manure tea is prevalent among horticultural farmers in Kenya due to its reputation as a quick-acting growth stimulant than synthetic fertiliser. However, these assertions are yet to be substantiated. In addition, the effects on the rhizosphere and on the crops are limited. Therefore, an experiment was conducted to study the effect of chicken manure and chicken manure tea on growth and yield of cabbage (*Brassica oleracea var. capitata*). There were four treatments: chicken manure; chicken manure tea, combination of chicken manure tea plus chicken manure and NPK (control). The seedlings were transplanted in 10 litre containers and arranged in a randomized complete block design under a poly tunnel conditions. Data collected included soil pH, selected soil and tissue minerals analysis, vegetative parameters (stem length, leaf width, leaf length and number of leaves) and marketable heads. The data was subjected to R statistical tool and means separated by Tukey test at 5% level of significance. Results from the trial showed that all forms of chicken manure, especially the combined treatment of chicken manure plus manure tea, had a significant effect during the early stages of development but these effects were cancelled out during the later stages of development. Chicken manure treatment gave the smallest marketable heads than the control (NPK). In terms of tissue nutrient, NPK had the highest nitrogen and phosphorus concentrations while the combined chicken manure and tea gave the lowest content. High nitrogen content in vegetable tissue is often discouraged as is associated with several ailment. Soil samples indicated that the all the three chicken manure treatments improved the soil nutrient status and improved soil pH while the NPK declined the soil pH. In spite of the overall positive effects of chicken manure treatments, the benefits from the containers needs to be validated under field conditions.





Key words: cabbage, chicken manure, chicken manure tea, nitrogen, NPK fertilizers

Effects of varying shading regimes on total monomeric anthocyanins in purple tea (*Camellia Sinensis* (L.) O. Kuntze) cultivar with seasons and sites in Kenya.

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Abstract

A purple leaf tea (Camellia Sinensis (L.) O. Kuntze) variety, namely TRFK 306, is an anthocyanin-rich tea cultivar that was developed in Kenya by KALRO- Tea Research Institute and released to farmers for adoption in 2011. Since then, it has registered considerable adoption and with many farmers preferring it to the traditional green tea varieties mainly due to its high health related biological functions and more income to farmers. However, the loss of purple pigmentation to green colour during the dry and hot seasons has been observed with likely accompanying compromised quality resulting into doubt regarding sustainable production of high quality purple tea throughout the year. The adoption of the purple tea provides a future remedy in tea product diversification and value addition particularly in Kenyan tea industry where over-reliance on one major product, black Cut, Tear and Curling (CTC) tea which has not been generating favourable earnings of late. Therefore, this study was undertaken to examine the effects of varying shade establishments, seasonal changes and geographical location on the composition of selected bioactive molecules more so anthocyanins. This study was conducted at two sites in Kericho and Nandi counties using four shading regimes (treatments) at 0%, 30%, 60% and 90% by suspending black polyethylene nets horizontally 1.5 meters above the top of the crop canopy over the entire experimental layout. This was done to provide 100, 70, 30 and 10% light intensities penetration respectively with net suspension held at constant level. Each treatment was replicated three times. Leaf samples comprising two leaves and a bud, were collected for processing as: CTC aerated and CTC un-aerated purple teas, aerated





and un-aerated hand-crafted (rolled) orthodox purple teas. Processed tea products were kept in air tight bags for Total Monomeric anthocyanins analysis using UV/VIS Spectrophotometer. The results show that seasons, site and shedding levels and products showed significant variation ($p \le 0.05$) with 90% shading level having the highest total monomeric anthocyanins overall means (314.8mg/l). Cold and wet season had the highest content at 186 mg/l while non-aerated orthodox purple tea processed product showed the highest level at 417.5mg/l. Timbilil-TRI Kericho county site had the highest content in comparison to Kaptumo (Nandi Hills) Nandi County at 262.2mg/l. This result can be used in environmental manipulation for the sustainable production of high quality purple tea throughout the year.

Key words: shading regimes, total monomeric anthocyanins, purple tea, season, sites

Evaluation of selected hydroponic media on growth and yield of spinach (*Spinacia oleracea*)

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Abstract

Hydroponics, the use of soilless media for growing of crops is gradually gaining popularity in Kenya especially in urban areas where availability of good soil is a challenge due to construction works. Since soil is bulky in nature, transporting it may not be very easy and it is also expensive. This technique is environmentally sound since there are less incidences of soil borne diseases therefore reducing use of chemicals and decreasing pollution effects. The broad objective of this study was to determine the growth and yield of spinach using selected hydroponic media namely; peat moss, coco peat and construction sand. Soil was used as a control. The study was carried out at Karatina University greenhouse. The treatments (peat moss, sand, coco peat and soil) were replicated thrice in the green house using complete randomized design (CRD). Data was collected on growth parameters that included; take off percentage, number of leaves, plant biomass, leaf length and leaf yield. Collected data was subjected to GenStat computer software to obtain analysis of variance (LSD) at probability level of p<0.05. The findings of the study showed that the selected





hydroponic media were effective in production of spinach. Peat moss and coco peat recorded similar results as soil in all the attributes studied implying that these media can be used in urban areas where soil may not be available. This study recommends further research to assess the quality of hydroponically grown spinach.

Key words: Hydroponics, spinach, coco peat, peat moss, sand, soil

Commercial *Arbuscular mycorrhizal* fungi (AMF) and Rhizobia improve growth of *Vigna radiata* (L).

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Abstract

Phosphorous is an essential mineral for plants. Its accumulation in leguminous plants increases the rate of nodulation, root length, biomass, and yield. This study investigated the effects of commercial Arbuscular Mycorrhizal Fungi (AMF) and rhizobium inoculum on growth of *Vigna radiata* (L). A 2³ factorial experiment was set up with three factors, rhizobium (Biofix®), AMF (Rhizatech®) and phosphorus fertilizer each with two levels -with or without either of the treatments in a randomized complete block design. The plants were subjected to eight treatments (all treatment combinations), each with five replicates. Treatments included a control, sole application of phosphorus fertilizer, rhizobia and AMF inoculants, combined application of either rhizobia and AMF, AMF and phosphorus, rhizobia and phosphorus and finally, combined application of rhizobia, AMF and phosphate fertilizer. Measurements of plant height, number of leaves, shoot and root dry weights were recorded. Plant growth parameters were differentially affected by the application of AMF and Biofix. Apart from the number of leaves, plant height, root and shoot dry weight were higher in plants inoculated with AMF and rhizobia alone when compared the control. Plants applied with phosphorus fertilizer were found to have lower weights than plant without phosphorus. For shoot weight, there was a significant interaction between AMF, rhizobia and phosphorus. Plants with AMF had higher weight. However addition of phosphorus or rhizobia reduced plant size- AMF and phosphorus or rhizobia and phosphorus both showed a reduction in plant growth as compared to AMF and rhizobia alone and the control. The results of this study indicate that, generally, the use of AMF and rhizobia bio fertilizers improves V. radiata growth,





but addition of AMF was more effective than rhizobia application, phosphorus application or a combination of these.

Key words: Arbuscular Mycorrhizal Fungi, AMF, Phosphorus fertilizer, Rhizobium, Vigna radiata.

Dual output per horticultural unit area: combining horticultural crops with agri-photo voltaic shading

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Abstract

As the world trends in pursuit of renewable energy to combat adverse effects of global warming on crops, there is need for horticultural farmers to incorporate renewable energy harnessing and use with crops production from the same area. However, there are many questions that need to be addressed while combing crop production with solar harvesting. For instance, how would photo-voltaic (PV) panel shading affect growth and yields of such crops? To answer some of these questions a pilot project of 24 PV panels, 2 m high x 12.5 m long x 3.3 m wide structure was fixed with solar panel (PV) and vegetables were cultivated (plot of 12 m x 3 m) under the solar panels in Taita- Ngerenyi for a period of 24 months. Depending on sun's rays radiation the area under PV received 75-100 % shading. Various vegetables like kales, cabbage, black nightshade and Swiss chard were cultivated sequentially under the photovoltaic panels. An area receiving full strength weather elements surrounding the solar panel structure was used as a reference area (control) having similar crop as under the panel. The solar energy generated from the photo-voltaic panels was stored on lead acid batteries and utilised to power a computer lab on daily basis. On average 14 kilo watt hour were harvested and utilised per day. Depending on crop, growth parameters and yields were recorded and data subjected R statistic for ANOVA. The results indicates that there was no significant shading effect on kales and black night shade grown under the solar panels compared to that of the reference area. However, there was significant (p < 0.05) shading effect noted on cabbages and French beans to that of the





reference area. Swiss chard showed a contrasting trend depending on the season they were grown. Kales under the shade produced 12% more yields to that of the reference area. This implies that combining crop production and solar harvesting on the same plot area is feasible and more beneficial for electrification for off grid farmers. To validate these results, more crop species and integral quality properties need to be tested. The experimentation is ongoing and more information will be shared.

Key words: Electrification, dual output, renewable energy

Effects of nitrogen and phosphorus fertilizer application on yield and quality of purple tea (*Camellia Sinensis (L) O. Kuntze*) in Nandi and Kericho Counties

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Abstract

Purple tea (*Camellia sinensis*) cultivar is a recently released tea variety in Kenya that is rich in anthocyanins, which are potent antioxidants with positive implications to human health. A study was carried out to determine the effects of applied N and P on mineral N, available P, anthocyanin content, antioxidant activity and yield of purple tea in Nandi and Kericho Counties over a period of six months. Fertilizer application of varying N and P nutrient regime was administered in established tea fields in Nandi and Kericho Counties. Random complete block design was employed with three replications. The results indicated that the levels of mineral Nitrogen (N) was positively influenced by the amount of applied at (0, 75 and 150KgN/ha/yr) N at a depths of 0-20cm and 20-40cm in both Nandi and Kericho, however the levels of Mineral N decreased gradually overtime. Phosphorous (P) fertilization at (0, 15 and 30KgP/ha/yr) increased the levels of soil available P at 0-20cm in both sites. At depths of 20-40cm there was no significant effect at $p \le 0.05$. There was minimal variation of soil available P overtime. The interaction of N and P fertilizer application gave significant increase at $(p \le 0.05)$ on purple tea yield, however there was no significant differences on yield with fertilizer rates of 75N,0P; 75N,15P; 75N,30P; 150N,0P; 150N,15P and 150N,30P; at ($p\leq 0.05$) both in Nandi and Kericho. Results also showed that yield subsequently increased with increase in N rate. Variation in P rate did not influence the yield both in Nandi and Kericho. The anthocyanin levels were influenced





by N and P application in Kericho. P application did not have any significant effect on anthocyanin in Nandi. The antioxidant levels were not influenced by both N and P application in both study sites. In conclusion, it was evident that application of N and P plays a significant role in yield and the quality parameters of purple tea.

Key words: fertilizer, mineral, yield, anthocyanins, antioxidants

The effect of dodder (*Cuscuta Spp*) on growth and quality of six tea clones in a green house.

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Abstract

There are about 400 species of known parasitic plants, some become weeds posing a threat to major crops. Among the agricultural parasitic plants of the world is dodder. Plants of the genus *Cuscuta*, also known as dodder belong to the family of *Cuscutaceae* and consists of about 200 species found almost everywhere in the world. In Nandi, tea (Camellia sinensis) bushes have been under dodder attack since 2013 and it is a threat to the existing tea clones, ecosystem and human livelihood. The parasitic plant stresses tea plant growth as it depletes nutrients and other soluble components resulting in yield losses. A study was conducted to assess the effect of Cuscuta on tea plant height, the number of leaves, leaf area, trunk diameter, dry weight and quality in the greenhouse. The experiment was laid out in a complete random design with three replicates. The twigs of *Cuscuta sp.* (3 twigs of 11 inch length) were collected from infected tea varieties (clones) at Nandi hills tea Estates and were used to infect potted tea plants in the Tea Research Institute (TRI) green house at Kericho. The *Cuscuta sp* affected harvest biomass of all the 6 clones (TRFK 430/90, TRFK 31/8, TRFK 306, TRFK303/577, TN41-3 and TRFK 301/4), Trunk diameter of clone TRFK 306, leaf area of clones TRFK 31/8 and TRFK 301/4 compared with the controls. Cuscuta sp did not have any significant effect on biochemical quality between clones and controls with respect to the percentage of total and individual catechins in % GC (0.33-0.76), % EGC(1.00-5.57), % +C(0.07-





0.35), % EGCg(2.57-10.34), % EC(0.83-3.60), % GCg (0.04-0.40), % ECg(0.99-4.93), % Cg(0.00-0.29), % GA(0.00-0.08) and % Caffeine(1.58-3.92). This results indicate that there may be varietal preference in the attack by the parasite. Further research under natural environment should be carried to confirm greenhouse results.

Key words: Cuscuta spp., tea varieties, growth, quality, Morphology

KEYNOTE ADDRESS TWO

Keynote Topic 2: Climate-smart postharvest technologies to reduce food loss and waste in horticultural value chains: Case study Of 'Zero Loss' Centres

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Abstract

An estimated 1.3 billion metric tons or 30% of all the food produced globally is lost or wasted every year. Fruits and vegetables (FV) alone account for 40-50% of the total losses. When food is lost or wasted, all the resources that were used to produce it, including water, land, energy, labour and capital are wasted. In addition, the disposal of food in landfills, leads to greenhouse gas (GHS) emissions, contributing to climate change. Therefore, food loss and waste (FLW) reduction has tangible societal and environmental benefits. This includes increased food availability to the most vulnerable; reduction in GHG emissions; reduced pressure on land and water resources; and increased productivity and economic growth. Food loss and waste in fruit and vegetables result from a myriad of causes/drivers. These include sub-optimal preharvest practices that negatively affect quality at harvest and subsequently poor harvest and postharvest handling of the produce. Among other interventions, many studies have identified proper cold chain management and small-scale processing technologies as critical to reduction of FLW in horticultural value chains. Therefore, this paper highlights the potential benefits of application of innovative climate-smart cold storage and small-scale processing technologies in 'zero loss' aggregation centres at the farm level and fresh produce markets. The goal of zero-loss centres at the farm level is to optimize smallholder farmers' returns by ensuring that no produce received is lost or wasted – it is either channelled to targeted fresh produce markets or





transformed into shelf-stable products. On the other hand, cold storage facilities strategically located in fresh produce markets could improve sourcing logistics and storage of the unsold fresh produce for later sales. Overall, application of innovative postharvest technologies at the appropriate stages in horticultural value chains will not only contribute to reduction of postharvest losses but also create agribusiness opportunities and improve returns for smallholder farmers. Ultimately these interventions will contribute to responsible/sustainable production and consumption envisaged under Sustainable Development Goal (SDG) 12 and specifically target 12.3 that calls for halving postharvest food losses along production and supply chains by the year 2030.

Key words: Postharvest, Food Loss, Food Waste, Climate-smart, Cold Storage, Agro-processing

1.3 POSTHARVEST HANDLING AND QUALITY

Investigation of steaming processing technology on biochemical properties of purple tea (*Camellia Sinensis*)

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Abstract

Purple tea, a variety of *Camellia sinensis* developed by the Tea Research Institute (TRI) contain different bioactive compounds, polyphenolic such as epigallocatechin gallate (EGCG) and epicatechin gallate (ECG) found in conventional green leaf tea and the unique types of purple anthocyanidins with anti-oxidant properties. The recommended processing technology of this tea has been the same as that of non-aerated (non-oxidized green teas) where the tea is enzyme inactivated rather than oxidized thus preventing enzymatic oxidation of the polyphenols. Anthocyanins have low stability if subjected to harsh heat processing conditions at high temperatures for a long time as in the case of CTC aerated black teas. The aim of the study therefore was to investigate an alternative processing technology using steaming purple tea leaves. Experimental treatment for purple tea leaves were steamed at 85°C for 2 min, while the controls were processed under the standard green tea conditions using micro cottage processing equipment, at Tea institute, Karatina University. The biomolecules





profiling was characterized using High Profile Liquid Chromatography. Moisture content and total polyphenols had no significant difference amongst treatments ($p \ge 0.05$). Total anthocyanins and individual anthocyanin contents had statistically significant difference ($p \le 0.05$) between the treatments method used. Malvinidin was the highest at 98.71±0.23mg/l while pelargonidin the lowest at 3.22±0.14mg/l using the steaming technology. Antioxidant Activity showed significant difference among treatments. In conclusion, from the current study, steaming before rolling gives better procedure for processing. However, further research is required to develop technology for retaining the anthocyanin content in purple tea for improved quality of the tea.

Key words: Purple tea, non-aeration, steaming technology, anthocyanins, Quality

Effects of multiples rounds of infusions on the quantities of quality parameters in brewed green, black and purple teas

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Abstract

Tea, the second most consumed fluid after water, is drunk by many communities and people of different classes, from the very rich to the poorest. In some communities, same made tea can be infused several times to increase available cups. The multiple infusions affect the levels of the quality parameters of each infusion. The influence of brewing green and black CTC and orthodox teas multiple times on the biochemical quality parameters were investigated. Two tea varieties TRFK 6/8 (green leaf variety) and TRFK 306/1 (purple leaf variety) were processed into black and green CTC and orthodox teas. The teas were subjected to a series of multiple brewing and the resulting liquors tested for total polyphenols, catechins and plain tea quality parameters vis theaflavins, thearubigins, total colour, and brightness values. There was decline ($p \le 0.05$) in the biomolecules concentration with each dilution up to the sixth dilution. However after the second and third brews from CTC and orthodox teas. After the second and third brew in CTC and orthodox teas, the levels of the second and third brew in CTC and orthodox teas, the levels of the second second processes the second second processes the second second processes the second second process of the second second process of the second second process of the second and third brews from CTC and orthodox teas.





biochemicals were very low. The results demonstrated that multiple brews from tea can be made only up to the second and third rounds for CTC and orthodox teas, respectively. Within these brews over 70% of the biochemicals responsible for quality had been infused into the brews. This study demonstrates that in tea drinking communities where multiple infusions are done from same tea, maximum number of infusions should be two and three for CTC and orthodox tea, respectively. Beyond this the tea residue should be discarded.

Key words: Camellia sinensis, extractions, biochemicals, CTC tea, Orthodox tea

Evaluating The Efficacy Of Edible Plant Extracts On Shelf Life Of Mango (*Mangifera Indica*) And Tomato (*Lycopersicon Esculentum*)

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Abstract

Plant extract preservation methods can be adopted to reduce the problems that have been caused by indiscriminate use of synthetic chemicals on preservation of fruits. The objective of this study was to evaluate the efficacy of ginger (, garlic and Aloe vera plant extracts on preservation of mango and tomato. An experiment was set in a completely randomized design (CRD) in Karatina University agricultural laboratory. The specific objectives of the study were: to determine the efficacy of ginger, garlic and *Aloe vera* extracts on total soluble sugars (TSS) of tomato and mango; to evaluate the efficacy of ginger, garlic and *Aloe vera* extracts on texture firmness of mango and tomato; to evaluate the efficacy of garlic, ginger and Aloe vera extracts on color change of tomato and mango fruits. Tomato and mango fruits were coated with formulations of ginger, garlic and Aloe vera extracts. Two controls were used; salicylic acid and no coating. The coated and uncoated fruits were stored in same physiological conditions. Color change was scored by use of a color chart. Total soluble sugar (TSS) content was determined by brix method. Data collected was subjected to analysis of variance (ANOVA) using Genstat software version 12.1 and means separation was done using Fischer's protected least significant difference (LSD) at a probability level of P \leq 0.05. From the study *Aloe vera* treatment performed the best in the enhancement of shelf life of mango and tomato. Garlic was second in effectiveness followed by ginger. Salicylic acid and non-coated fruits performed the





least. In conclusion, *Aloe vera* is a good enhancer of shelf life in tomato and mango, since it is easily available, easy to apply and has no negative effects on fruits and human. This study recommends *Aloe vera* for use by producers and consumers of tomato and mango for postharvest management of these fruits.

Key words: Mango, tomato, shelf life, plant extracts

A colorimetric probe for detection of gibberellic acid exudated by *Ralstonia solanacearum* in tomato

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Abstract

Ralstonia solanacearum is a soil-borne bacterium causing bacterial wilt disease in over 250 plant species particularly crops in the Solanaceae family including tomato and potato. Kenya is ranked sixth among the leading African countries in tomato production, with approximately 397,007 tonnes accounting for 14% of total vegetable production and 6.72% of total horticultural crops in the country. Different methods for *R. solanacearum* identification and detection exist but face a wide range of limitations for use. These methods techniques involving extensive sample preparation and analysis making them complex, expensive, time-consuming, and require skilled labour. This limits the effectiveness of any remedial strategy. There is therefore a need to develop a detection method that is rapid, efficient, and user friendly. A gold nanoparticle-based colorimetric probe capable of detecting gibberellic acid exudated by R. solanacearum was developed. Upon binding selectively with an analytes, a colorimetric probe will elicit color changes that can be observed by the naked eyes. The AuNPs were synthesized through a reduction with citrate ion. Soil samples were collected from the rhizosphere of tomato plants, exhibiting bacterial wilt symptoms. Pure cultures of *R. solanacearum* were isolated using a modified Kelman's TZC medium. Gibberellins were extracted from the culture of *R. solanacearum* using ethyl acetate and characterized using Fourier transform infrared spectroscopy (FT-IR). Extracted gibberellins were added to the Red AuNPs solution. The colour change to





from red to purple and finally to blue further confirmed the presence of the Bacterial wilt causing pathogen in the infected soils. The distinguishable colour change facilitates the development of a simple sensor for bacterial wilt detection. The high sensitivity of gold nanoparticles plays a key role in designing this simple colorimetric pathogen probe.

Key words: Colorimetric probe, Detection, AuNPs, bacteria, biosensor

Evaluation of catechins content of second generation purple tea against green coloured tea varieties.

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Abstract

Tea polyphenols and catechins have gained prominence in determination of tea quality. Tea leaves contain large amounts of catechins and their derivatives and these have shown positive effects on human health. A study was carried out to determine catechins content in second generation purple leaf tea varieties found in four distinct tea growing areas namely Timbilil Kericho, Nandi, Chesumot Kericho and Kangaita. A total of 130 purple leaf tea varieties and 2 standard green coloured varieties were used (one Kenyan (TRFK 6/8) and the other a Japanese (Yabukita) varieties). Leaf samples were collected from the sites, processed by microwaving and analyzed for catechins including Catechin (+C), Epicatechin, Epigallocatechin (ECG), Epcatechin gallate (EG) and Epigallocatechin gallate (EGCG). The results showed that individual catechins varied significantly at ($p \le 0.05$); EGCG (0.26-8.09%), ECG (1.28-5.55%), EC (0.44-3.34 %), EGC (0.63-6.58 %), C (0.12-1.72 %) and the total catechins content range was (5.12-24.38%). Remarkable high values for total catechin content for three purple coloured cultivars (TRFK 306 Chesumot 17 (19.82%), TRFK 306 Chesumot 15 (21.13%) and TRFK 306 Chesumot 14 (24.38%) against a standard green coloured cultivar TRFK 6/8 (19.22%) was observed and 71 purple (Ranging between 12.62 -24.38%) coloured varieties against Yabukhita (12.52%) which is the best Japanese cultivar for green tea, The findings suggest that purple coloured varieties could be exploited more for processing specialty teas because of their implied health benefits based on their catechin contents which are potent antioxidants together with





anthocyanins. The results further indicated that the level of catechins in tea were significantly different ($p \le 0.05$) and varietal dependent. It is concluded that the level of catechins in tea plants are varietal dependent, although environmental factors has effects on the synthesis of flavonoids. The results demonstrated that the differences in the accumulation of catechins among the different tea varieties could be important for the discrimination of clonal diversity under different agronomical zones.

Key words: Tea; Health; Camellia sinensis; Catechins; Variation; Kenya

Effect Of Plucking Standards On Clonal Tea (*Camellia Sinensis*) Selenium And Aluminium Levels

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Abstract

The tea plant accumulates high levels of aluminium (Al) in the leaves. Additionally, the leaf contains appreciable amounts of selenium (Se). However, the partitioning of the elements in the leaf may vary with age of the leaf. Plucking standard may therefore have influence of the elements in the tea brew. Selenium plays an important role in detoxification of heavy metals in the body and has antioxidant activities. Al plays no essential role in human beings, but there are health concerns associated with high Al intake. Tea is Al accumulator and the plant tolerates high amount of the element. These properties have increased interest in determining levels of Se and Al tea as consumption of tea beverages contributes the element to human system. Although recommended plucking standard is uniform in Kenya, the practiced standard varies with farmers. However, variations in tea Se and Al with plucking standards have not been established in different cultivars under same agronomic inputs. Variations of Al and Se in clones TRFK 6/8, AHP S15/10, TRFK 31/8 and EPK TN14-3 at different plucking standards were assessed in Timbilil, Kericho. Se levels declined ($p \le 0.05$) with coarse plucking standards at different rates in the clones causing significant $(p \le 0.05)$ clonal and plucking standards interactions effects. Al levels increased $(p \le 0.05)$ with coarse plucking standards increase. The rate of increase varied with clones, again causing significant (p≤0.05) clones by plucking standards interactions effects. At the recommended 2 leaves + bud plucking standard, both Al and Se within





CODEX recommended ranges in all clones. The results suggest that plucking standard is one way of controlling Al and Se in tea and that plucking two leaves and a bud ensures compliance with CODEX recommended levels of Al and Se in tea.

Key words: Selenium, Aluminium, Camellia sinensis, plucking standards, clones

1.4 SOCIO-ECONOMIC AND ENVIRONMENTAL ISSUES

In vitro antibacterial and antifungal activities of tea seed oil against *E. coli, S. aureus, C. albicans, C. neoformans* and *T. mentagrophytes*

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Abstract

The presence of pathogenic bacteria and fungi causing infections in humans and animals brings about the need to research on alternative antimicrobial agents to fight and prevent existing and emerging infectious diseases. In the present study, the antibacterial and antifungal activity of Camellia sinensis TRFK 301/5 (green leaf variety) and TRFK 306 (purple leaf variety) and *Camellia oleifera* tea seed oil and two selected oils i.e. olive and eucalyptus oil, were evaluated against bacteria; *Escherichia* coli, Staphylococcus aureus, and fungi Candinda albicans, Cryptococcus neoformans and Trichophyton mentagrophytes. Polyphenolic composition profile and antioxidant activity of tea seed oil from C. sinensis and C. oleifera were evaluated. C. oleifera was superior to C. sinensis in its biochemical profile. The oils differed significantly $(p \le 0.05)$ in the levels of total polyphenols, and catechins. *Camellia oleifera* contained significantly ($p \le 0.05$) higher amounts of catechins and polyphenols and exhibited higher antioxidant activity with a higher DPPH radical scavenging activity as compared to C. sinensis. The catechin fractions in the oils that contributed significantly to their antioxidant activity were, GA (r = 0.9542), C (r = 0.9543), EGCG $(r = 0.998^*)$ and EC $(r = 0.6636^*)$. The *Camellia* oils studied significantly inhibited the activity of the microorganism, S. aureus and E. coli though at differing degrees. The *camellia* oils inhibited the growth of fungi as exhibited by *T. mentagrophytes* and





C. albicans however it had no effect on *C. neoformans*. This study concludes that tea seed oil from C. sinensis and C. oleifera are a potential source of beneficial phytochemicals and antimicrobial agents.

Key words: C. sinensis, C. oleifera, polyphenols, catechins, anti-fungal, anti-microbial

Factors influencing avocado marketing in Nyeri County: A case study of Karatina ward

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Abstract

Marketing of agricultural produce is important among small scale farmers because their livelihoods depend on earnings from produce sales. In Kenya like other developing economies, smallholder farmers are characterized by poor market participation due to lack of market information. In Nyeri county, avocado has been perceived to have high market value, resulting in trade-offs with staple food. Despite the high market value for avocado, there is low market participation by small scale producers. Although a household may have a few (4 to 10) avocado trees, many growers do not take the produce to market. The fruits are consumed by family members or given to neighbours and friends. Most of the fruits get wasted in the fields where they are grown. Rarely are fruits taken to markets. The aim of the study was to assess the factors that influence marketing of avocado by small scale producers in Nyeri County. Specifically, the study evaluated the socio-economic factors affecting marketing of avocado by small scale farmers, assessed the institutional factors affecting marketing of avocado by small scale farmers, and also determined the profitability of different marketing channels used by avocado farmers. Primary data was collected using questionnaires and interviews while secondary data was obtained from publications. Data was analyzed using Statistical Package for Social Scientists (SPSS). Multiple linear regression model, gross margin analysis and binary logit regression model were used in data analysis. The study noted that age, education level and farmer market experience, positively and significantly influenced marketing of avocado. Household size however, had a negative influence on marketing of avocado fruits. Gross margin analysis indicated that marketing through formal channels was





more profitable compared to informal channels. This study recommends capacity building for avocado farmers to be undertaken by relevant stakeholders.

Key words: Avocado, marketing information, marketing channels, profitability

Perception and adoption level of urban horticulture technologies, Nairobi County, Kenya

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Abstract

Urban and peri urban areas face numerous challenges such as food insecurity, air pollution, insufficient water supply, wasteinadequate basic services, disposal problems and high population. As a result, number of horticultural technologies have been adopted as survival strategies. The farmers' perceptions, stakeholders and social economic are key factors in the success or failure of continuous innovations adoption. An investigation was done to evaluate the main social economic factors which influence the adoption of horticultural practices and how knowledge transfer influence the adoption of urban horticultural technologies. The findings were based on the analysis of 580 respondents: 138 in Kasarani, 195 in Mathare and 247 in Kibera. Data was collected by use of questionnaires and observations. Information on social economic characteristics was collected. Frequencies and percentages were used to analyze the data using Statistical Package for Social Sciences (SPSS) and the chi -square was also performed. The major perceived benefits of adoption of urban horticultural technologies include the increased food security, increased income and well use of open spaces. Security of crops, pests and diseases, slashing of crops and competition for the limited space from other users are perceived to be the main challenges hindering the diffusion of the innovations. With respect to space identified for farming, over 20% of the farmers mentioned along the road reserves. More than 65% of the respondents were female. Among the five main horticultural technology transfer methods identified, colleague farmers were the most common source of information. The study also shows that there is positive relationship between age of respondents and technology transfer in periurban areas at 95% level of confidence, statistical test.

Key words: urban and peri urban farmer, horticultural technologies, food insecurity









The seed cotton industry in Kenya: Problems, prospects and revival strategies

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Abstract

Cotton is presently grown in twenty two counties in Kenya spread across Central, Coast, Eastern, Nyanza, Rift Valley and Western regions. Cotton production has been well below potential in recent years due to various constraints including: non availability of quality seeds, inappropriate production technologies, lack of access to credit and high cost of farm inputs. For the cotton industry to be revived various strategies have to be put in place including: establishing efficient rural finance and credit supply system for small holders and rural primary agro processors, ensuring policies, institutional and legal frameworks are investor friendly, facilitating long term investments in farm improvement technologies and improving governance of cooperative sector. The study is based on premise that policy, institutional and economic content is candid in addressing problems in cotton industry and helps arrive at prospects essential in de-limiting the challenges. Primary data was obtained through field survey using questionnaires and interviews on a sampled 100 cotton farmers and 5 CODA and 5 MOA staff in five cotton growing zones by stratified random sampling method. Secondary data from various sources (KALRO, CODA and MOA reports) was looked at, compared and analyzed to come up with prospects and strategies for solving production and marketing problems. The qualitative data analyzed showed farmers face problems of acquiring credit for use in production of cotton, plowing, planting, weeding, pest control, harvesting and transportation of seed cotton to the marketing outlets. The prospects and interventions suggested are putting in place policy and regulatory framework to address vacuum that has existed after the collapse of cotton board. Other measures include streamlining marketing system to solve price variation and fluctuations leading to local farmers' maximization of the African Growth Opportunity Act initiative by United States government that was extended from 2015 to 2025. It was concluded that there need to invest in cotton industry by government, private sector and international community for its revival.

Key words: Cotton, problems, prospects, revival strategies.





Antimicrobial properties of specialty tea extracts from different tea *Camellia sinensis* cultivars on selected pathogenic bacteria and fungi

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Abstract

Tea Camellia sinensis is known for its high levels of phenolic compounds which possess antimicrobial activities. Infectious diseases caused by pathogens are threatening human health while the efficacy of some of the conventional antimicrobial agents have been weakened by microbial resistance. Development of natural antimicrobial products from plants with high potency and limited side effects is significant in overcoming antibiotics resistance. A study was conducted to determine antimicrobial properties of 5 selected tea cultivars against selected 3 pathogenic bacteria and 2 fungi including *Pseudomonas aeruginosa*, *Staphylococcus aureus*, Escherichia coli, Trichophyton mentangrophytes and Candida albicans. The extracts were prepared from green, black, yellow and oolong teas using water, absolute ethyl acetate and methylene chloride solvents and assayed for anti-microbial activities. The results showed that the tea extracts differed in the levels of antimicrobial activities $(p \le 0.05)$. The antimicrobial activity of ethyl acetate extracts registered the highest levels whereas the methylene chloride extracts resisted the least. The results indicate that plant extracts could be useful in fighting emerging drug-resistant microorganisms and choice of the solvent plays a prominent role in extracting and preserving antimicrobial capacities of medicinal plants. Camellia sinensis can be used as an alternative source of antimicrobial agent against infections caused by human pathogens.

Key words; Organic solvents, water, pathogenic bacteria, pathogenic fungi, tea extracts





Perenialization of annual vegetables: A path towards food security and sustainable ecological services

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Abstract

Perennial vegetables are a class of vegetables that live for more than three years and withstand multiple harvests. The benefits of perennial crops include: increased root carbon, reduced soil erosion, improved food and nutrition production and reduced emissions of greenhouse gases. The aforementioned benefits have stimulated great interest on improvement of perennial crops. Perenialization of elite annual vegetable cultivars is expected to improve food and nutritional security while providing ecological benefits. However innovative steps in perenializing cultivated annual vegetables have remained low owing to missing in published literature in this area. The purpose of this review is to highlight the potential of breeding and biotechnology in the development of perennial vegetables. The available literature show the existence of perennial genes in other crops especially grain cereals and oil crops. The existence of Crop wild relatives (CWR) provides hope for the genetic basis for vegetable perenniality. The greatest challenge is the transfer of the genes into annual elite vegetables without jeopardizing quality, yield and consumer acceptability. Conferring perenniality genes into annual vegetables through wide hybridization is restricted by genetic barriers. Utilization of genomic approaches such as marker assisted selection followed by hybridization may yield perennial vegetable genotypes. Linkage drag during hybridization further complicates wide crossing. Modern crop breeding approaches such as gene editing, marker assisted breeding, genetic modification, mutation breeding and genomic selection have great potential in developing perennial crops as well as unravelling mechanisms of perenniality in vegetables.

Key words: Crop wild relatives, gene editing, pereniality, vegetables





Determinants of credit access among smallholder dairy farmers in Kinangop Sub-County, Kenya.

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Abstract

Dairy farming plays a major role in the Kenyan agricultural sector as it is dominated by smallholder farmers who contribute approximately 80 per cent of the total milk production. In Kinangop Sub County, there are many credit service providers however, not all smallholder dairy farmers have benefited from such services despite high intensity of dairy farming in the area. Instead smallholder dairy farmers have continued to experience challenges such as limited access to financial services. Moreover, there is little empirical evidence on how credit access relates to smallholder dairy farm income in Kinangop Sub County since no similar study has been conducted in the study area hence the reason for selecting Kinangop Sub County. This study therefore analyzed the determinants of credit access among smallholder dairy farmers in Kinangop Sub-County. A total of 230 respondents were sampled from a population of 35,840 smallholder dairy farmers using both stratified and simple random sampling techniques and both structured and semi structured questionnaires were used to collect data. The study used descriptive survey research design. Results revealed that about 59.57% of smallholder dairy farmers were males, 69.57% were married and had a mean age of 39.4 years. The average household size was 4 persons. Formal schooling was also attained by the respondents, majority having an average of about 8 years of schooling. On average farmers had 2 dairy cattle per household, produced 341litres of milk per month and had 11 years of farming. Further the results revealed marital status, years of schooling, savings frequency, dairy farming practice, financial education, association membership and number of dairy cattle as the significant determinants of credit access. The study concluded that enhancing credit accessibility could be vital in increasing farm income and recommended formulating policies geared towards enhancing education of farmers to enhance credit accessibility of farmers in the study area. There is also need for the Government and other





stakeholders to provide financial training to dairy farmers and encourage them to join farmer associations and eliminate stringent collateral barriers and bureaucracies that discourage smallholder dairy farmers from accessing and participating in different credit schemes.

Key words: Credit access, Determinants, smallholder dairy farmers, Kinangop Sub-County.

SECTION TWO: ABSTRACTS OF POSTERS

2.1 POSTHARVEST HANDLING AND QUALITY

Characterization of microorganisms in made black cut tear and curl (ctc) from selected factories

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Abstract

Tea (*Camellia sinensis*) is considered a low risk food in terms of microbial contamination because of the way it is processed, packaged and consumed. However there are possibilities of microbial contamination along the value chain and for this reason care should be taken to eliminate them. A study was conducted to check the microbial quality of processed teas from selected factories. The study established the microbial safety of processed tea for human consumption in terms of the type and number of microbes detected. Made tea samples consisting of primary and secondary tea grades from the drier mouth and bins of 14 selected tea factories from the East and West of Rift Valley tea growing areas were collected. Packaged made tea samples were also collected from some factories and packers. The microbial quality of the teas were assayed as per the stipulations of Kenyan Black Tea Standard and ISO protocols





followed. The Standard Plate Count (SPC) technique was used for total microbial load, specific microorganisms yeast and moulds. *Escherichia coli* and *Staphylococci spp* were isolated from the samples. *Salmonella spp* was absent in the made tea samples. This shows that some teas did not meet the microbial quality standard requirements and there is need to improve on handling the teas to avoid contamination in the factories identified since there should be no *E. coli* and *Staphylococcus aureus*.

Key Words; Quality, bacteria, fungi, tea, storage, processing

Influence of harvest practices, packaging and transportation management strategies on postharvest losses of tomato in Kenya

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Abstract

Tomato (Solanum lycopersicum L.) is one of the most nutritious and popular vegetable crop in Kenya. High postharvest losses have been recorded for the crop leading to loss of nutrition and revenue. This is mainly due to farmers and traders using harvesting, packaging, transporting and storing practices that cause mechanical damage to the fruits leading to decay and hence high postharvest losses. There is therefore need to come up with safer methods of harvesting, packaging, transportation and storage to reduce these losses. The current study was carried out to determine the effectiveness of proper harvesting, use of plastic crate for packaging and transporting tomatoes while covered with black polythene sheet in the cool part of the day and then storing at ambient conditions of temperature and humidity in reducing postharvest losses. The trial was conducted twice in Kirinyaga County, Kenya from August to October 2020, where trained and untrained farmers participated. Treatments included use of proper harvesting practices, followed by packaging in plastic crates and transporting tomatoes while covered during the cool part of the day (Treatment 1) and harvesting using the farmers' practices, followed by packaging in wooden crates, transporting uncovered during the hot part of the day from Kirinyaga to Nairobi and then storing them (Treatment 2). Treatments were replicated three times in a completely randomized Data were collected on transport, storage losses and shelf life and were design.





subjected to analysis of variance (ANOVA) using Genstat, 15th edition software. The significantly (P<0.05) different means were separated using Fisher's unprotected least significant difference test. Treatments significantly (P≤0.05) influenced transport and storage losses. Tomatoes subjected to the first treatment had lower losses during transportation of 2.8% and 2% in the first and second trial, respectively while those subjected to the second treatment had losses of 4.8% and 3.5% in the first and second trial, respectively. Similarly, tomatoes subjected to the first treatment had significantly (P < 0.05) lower storage losses of 24% and 8% in the first and second trial respectively, compared to those subjected to the second treatment which had storage losses of 66% and 46% in the first and second trial, respectively. Shelf life was longer for tomatoes subjected to the first treatment of 14 days for both the first and second trial and of 11 and 7 days for the first and second trial, respectively for those subjected to the second treatment. The results show that harvesting tomatoes properly and use of plastic crates for tomato packaging coupled with transporting while covered during the cool part of the day has the potential of drastically reducing postharvest losses.

Key words: Tomato, harvest practices, plastic crates, wooden crates, transport losses, storage losses, postharvest losses