

Using a pesticidal plant requires managing knowledge-Intensive Inputs

P. Martin, P. J. Silvie, and M. Huchard

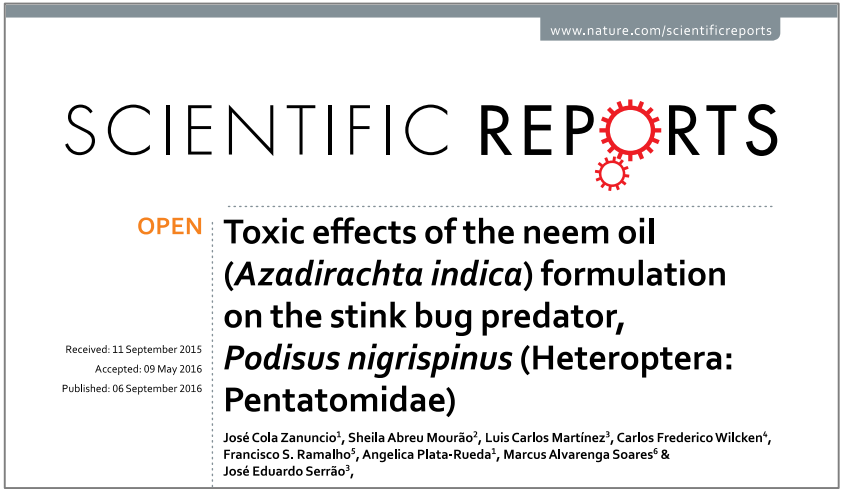
ICPP 3, Yamoussoukro, Cote d'Ivoire, July 25-29, 2022

Using plants as alternatives to pesticides and antibiotics

Risk: As pesticides, excessive or incorrect use of plants can be toxic to human

Predominance of some plant based product, e.g. neem

=> Non-intentional effects on predators using Neem



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SCIENTIFIC REPORTS

OPEN

Toxic effects of the neem oil (*Azadirachta indica*) formulation on the stink bug predator, *Podisus nigrispinus* (Heteroptera: Pentatomidae)

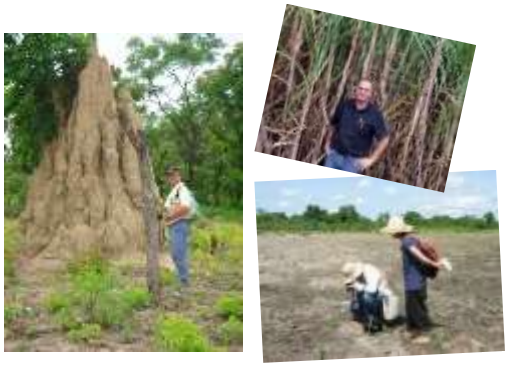
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Challenge: using local plants

Combining muldisciplinary information from various sources

Expert knowledge



Documents



...





...

Databases and other data grouping suports







...

The knowledge base Knomana

The PPAf network



85 UA
34 UE

Initiated in June 2015

The Project Knomana (2017-2018, GLOFOODS Meta-program, funding Cirad)

Partners	Burkina Faso - Univ. Ouaga 1 Cameroun - IRAD France - Cirad, IRD, Univ. Montpellier, Univ. Strasbourg
Activities	Complete the database on pesticidal plants using publications and develop a tool to navigate and explore it

Initial structure on Plant Health, Enrichment with knowledge on human and animal health, public health, environmental heath, chemical compounds, mortality, LDs, …

Plante	informations plante (caractéristiques		Ravageurs, maladies ou auxiliaires		Source de l'informati			
Nom latin		Organisme à protéger (espèce de plante)	Nom latin		uteur(s	Année	Titre article ou du document	Revue
Citrus sinensis		Monodora myristica	Aspergillus flavus		Djeuga	2017	Morphological and	Internatio
Citrus sinensis		Monodora myristica	Fusarium oxysporum		Djeuga	2017	Morphological and	Internatio
Citrus sinensis		Monodora myristica	Fusarium oxysporum		Djeuga	2017	Morphological and	Internatio
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Citrus sinensis		Monodora myristica	Fusarium oxysporum		Djeuga	2017	Morphological and	Internatio
Callistemon citrinu		Lycopersicum esculen	Phytophtora infestans		Dakole	2016	Antifungal potentia	Internatio
Callistemon citrinu		Lycopersicum esculen	Phytophtora infestans		Dakole	2016	Antifungal potentia	Internatio
Callistemon citrinu		Lycopersicum esculen	Phytophtora infestans		Dakole	2016	Antifungal potentia	Internatio
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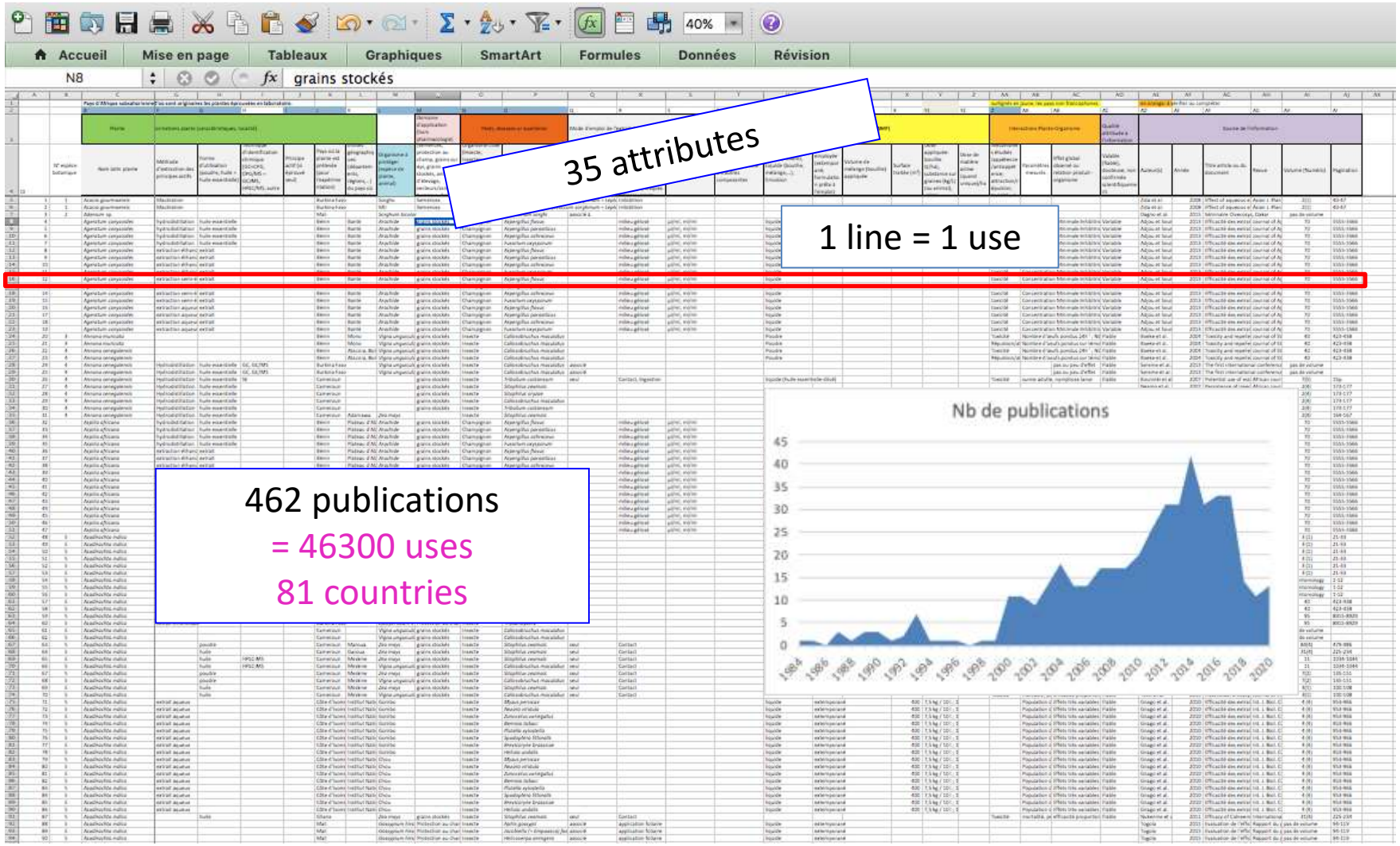


Catalogue of Life

Royal Botanic Gardens Kew | Plants of the World Online

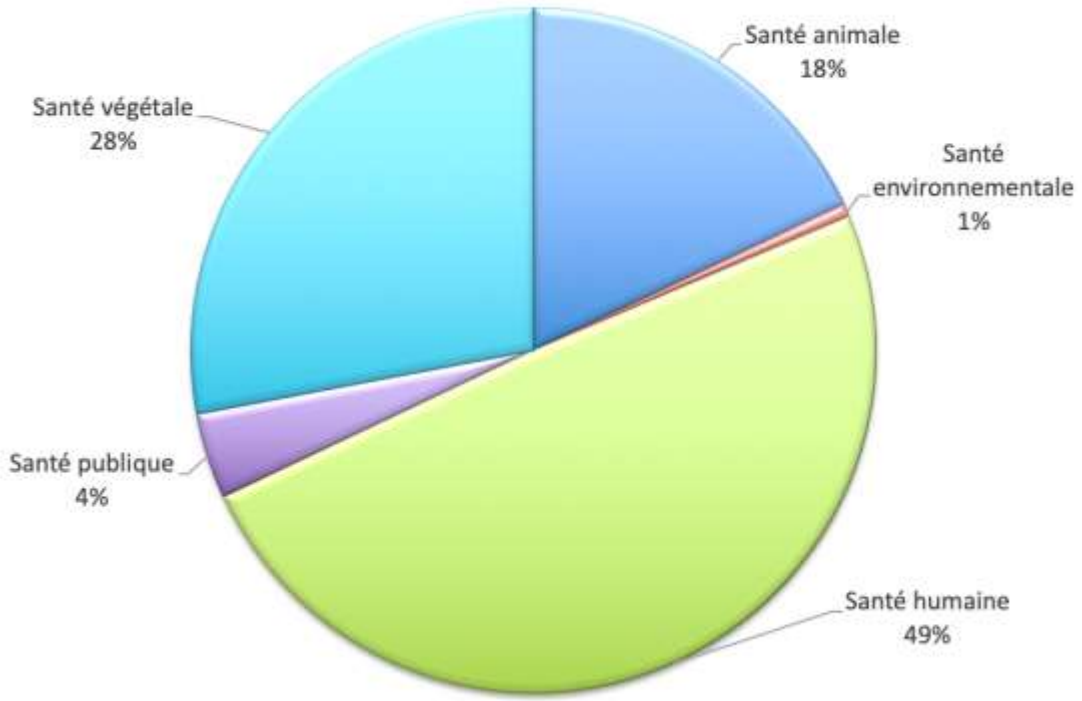
GeoNames

Knomana and its content in Nov. 2021



Uses /health and species protected by using a plant

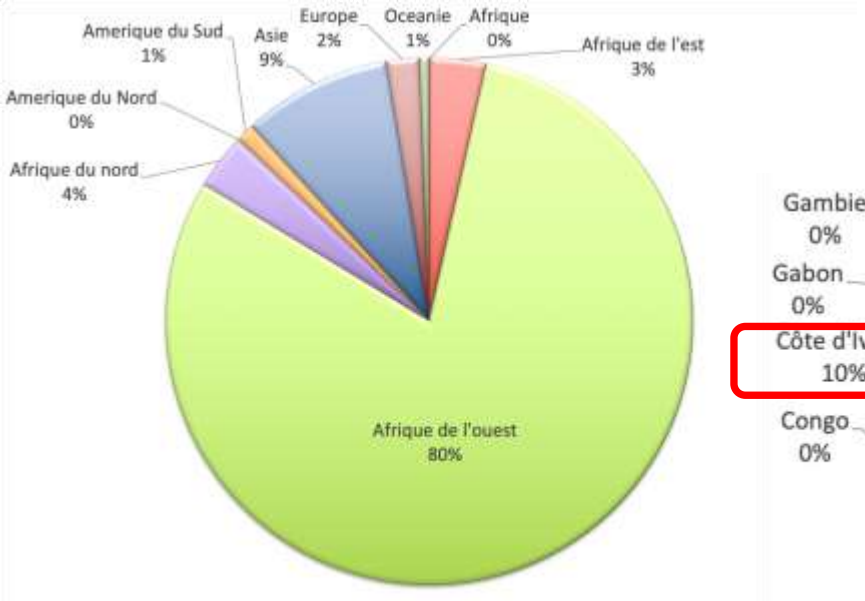
Distribution of the 46300 uses per health



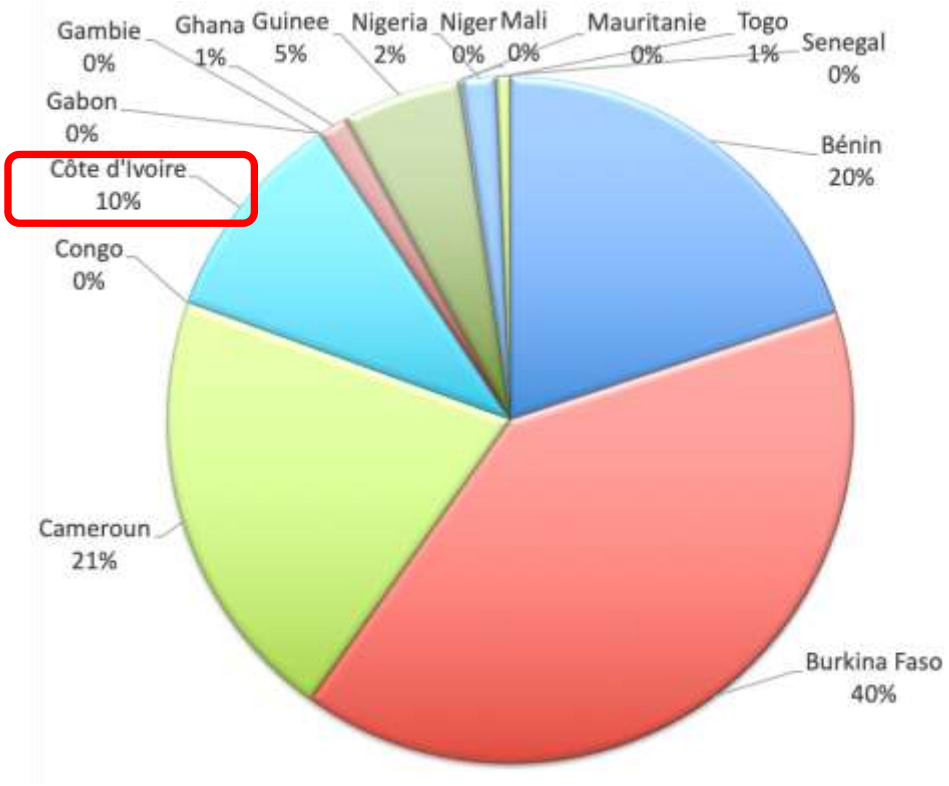
- 34 animal species: on land (cow, poultry, etc.) and aquatic (carp, shrimp, etc.)
- Human being
- 65 crop species

Knowledge location (Knomana, Nov. 2021)

In the World



West African countries



2540 species of plants with pesticidal and antibiotic effect

Plant name	Animal health	Environnemental health	Human health	Public health	Plant health	Total
Azadirachta indica	248	39	42	20	710	1059
Annona senegalensis	117		913	4	17	1051
Securidaca longipedunculata	1		874		20	895
Ximenia americana	61		810			871
Detarium microcarpum	57		770			827
Uvariodendron calophyllum			736			736
Parkia biglobosa	57		586		3	646
Bauhinia reticulata	1		620			621
Adansonia digitata	115		500			615
Vitellaria paradoxa	59		482			541
Ocimum gratissimum	80	5	130	23	278	516
Sclerocarya birrea	1		472			473
Tamarindus indica	64		370		6	440
Gardenia erubescens			432			432
Carica papaya	112		184		130	426
Guiera senegalensis	6		370		4	380
Entada africana			374			374
Ricinodendron heudelotii			350			350
Khaya senegalensis	64		270	4	8	346
Allium sativum	133	2	2	5	194	336
Senna alata	206		132			338
Vernonia amygdalina	281				54	335
...						
Zanthoxylum beecheyanum				1		1
Zanthoxylum fagara				1		1
Zanthoxylum oxyphyllum				1		1
Ziziphus abyssinica	1					1

60 plant species used in at least 2 regions of Africa

Plant name	East African countries	West African countries	North African countries	Plant name	East African countries	West African countries	North African countries
Allium sativum	X	X	X	*Harrisonia abyssinica*	X	X	
Azadirachta indica	X	X	X	*Harungana madagascariensis*	X	X	
Jatropha curcas	X	X	X	*Hymenocardia acida*	X	X	
Lantana camara	X	X	X	*Lawsonia inermis*		X	X
Syzygium aromaticum	X	X	X	*Lophira alata*	X	X	
Acacia nilotica	X	X		*Mentha spicata*		X	X
Acalypha paniculata	X	X		*Nicotiana tabacum*	X	X	
Acanthospermum hispidum	X	X		*Ocimum basilicum*		X	X
Annona senegalensis	X	X		*Ocimum gratissimum*	X	X	
Bauhinia thonningii	X	X		*Ozoroa insignis*	X	X	
Bidens pilosa	X	X		*Paullinia pinnata*	X	X	
Bobgunnia madagascariensis	X	X		*Phyllanthus muellerianus*	X	X	
Capsicum annuum	X	X		*Rauvolfia caffra*	X	X	
Cassytha filiformis	X	X		*Ricinus communis*	X		X
Cissus quadrangularis	X	X		*Securidaca longipedunculata*	X	X	
Citrus × aurantium		X	X	*Senna siamea*	X	X	
Combretum collinum	X	X		*Sorghum bicolor*	X	X	
Combretum molle	X	X		*Strychnos innocua*	X	X	
Corymbia citriodora	X	X		*Strychnos spinosa*	X	X	
Croton gratissimus	X	X		*Syzygium guineense*	X	X	
Croton macrostachyus	X	X		*Tagetes minuta*	X		X
Cymbopogon citratus	X	X		*Tamarindus indica*	X	X	
Dysphania ambrosioides		X	X	*Tephrosia vogelii*	X	X	
Entada abyssinica	X	X		*Thymus vulgaris*		X	X
Eucalyptus camaldulensis		X	X	*Tithonia diversifolia*	X	X	
Ficus sur	X	X		*Urtica dioica*	X		X
Ficus sycomorus	X	X		*Vernonia amygdalina*	X	X	
Ficus thonningii	X	X		*Vigna unguiculata*	X	X	
Gymnanthemum coloratum	X	X		*Vitex doniana*	X	X	
Gymnosporia senegalensis	X	X		*Ximenia americana*	X	X	

215 targeted species, among which 28 within at least 2 regions of Africa

Bacteria, Chromista, Eukaryota, Fungi, Insecta, Virus

Targeted species	East African countries	West African countries	North African countries
Aspergillus niger	X	X	X
Fusarium oxysporum	X	X	X
Spodoptera littoralis	X	X	X
Tribolium castaneum	X	X	X
Tuta absoluta	X	X	X
Aedes aegypti	X	X	
Anopheles gambiae	X	X	
Aspergillus parasiticus	X	X	
Bacillus subtilis	X	X	
Biomphalaria glabrata	X	X	
Brevicoryne brassicae	X	X	
Bursaphelenchus xylophilus	X		X
Callosobruchus maculatus	X	X	
Candida albicans	X	X	
Curvularia sp.	X	X	
Epicoccum sp.	X	X	
Escherichia coli	X	X	
Fusarium sp.	X	X	
Maruca vitrata	X	X	
Plasmodium falciparum	X	X	
Prostephanus truncatus	X	X	
Pseudomonas aeruginosa	X	X	
Salmonella enterica	X	X	
Shigella flexneri	X	X	
Sitophilus granarius		X	X
Sitophilus zeae-mais	X	X	
Sitotroga cerealella	X	X	
Staphylococcus aureus	X	X	

59 Culicidae species

Culicidae species	Country*	Culicidae species	Country*
Aedes aegypti	Argentina, India, Nigeria, Sweden, Thailand, Zimbabwe	*Anopheles minimus*	
Aedes albopictus	Cameroun	*Anopheles pharoensis*	
Aedes atropalpus		*Anopheles quadrimaculatus*	
Aedes camptorhynchus		*Anopheles sinensis*	
Aedes caspius		*Anopheles sp.*	
Aedes fluviatilis		*Anopheles spp.*	
Aedes gardnerii		*Anopheles stephensi*	India
Aedes increpitus		*Anopheles subpictus*	
Aedes intrudens		*Anopheles sundaicus*	
Aedes melanimon		*Anopheles tessellatus*	
Aedes spp.		*Anopheles vagus*	
Aedes sticticus		*Armigeres spp.*	
Aedes togoi		*Armigeres subalbatus*	
Aedes triseriatus	Burkina Faso	*Culex annulirostris*	
Aedes vexans		*Culex gelidus*	
Aedes vigilax		*Culex pipiens*	Turkey
Anopheles albimanus		*Culex quinquefasciatus*	France, India, Italy, Tanzania, Thailand
Anopheles annularis	India	*Culex sp.*	
Anopheles arabiensis		*Culex spp.*	
Anopheles barbirostris		*Culex tritaeniorhynchus*	
Anopheles braziliensis	Brazil	*Culex vishnui*	
Anopheles culicifacies	India	*Culicidae spp.*	
Anopheles darlingi		*Mansonia sp.*	
Anopheles dirus	Thailand	*Mansonia spp.*	Ethiopia
Anopheles funestus		*Mansonia uniformis*	
Anopheles gambiae	Cameroun, France, Italy, Kenya, Tanzania	*To be clarified*	Lebanon
Anopheles harrisoni		*Toxorhynchites sp.*	
Anopheles labranchiae		*Toxorhynchites splendens*	
Anopheles lesteri		*Verrallina carmenti*	
Anopheles marajoara			

*No country => laboratory experiment

724 pesticidal plant species (117 families) to control Culicidae

Family name	Family name	Family name	Family name
Acanthaceae	*Colchicaceae*	*Menispermaceae*	*Pteridaceae*
Amaranthaceae	*Combretaceae*	*Moraceae*	*Ranunculaceae*
Amaryllidaceae	*Connaraceae*	*Moringaceae*	*Resedaceae*
Anacardiaceae	*Convolvulaceae*	*Musaceae*	*Rhamnaceae*
Anadyomenaceae	*Cucurbitaceae*	*Myricaceae*	*Rhizophoraceae*
Annonaceae	*Cupressaceae*	*Myristicaceae*	*Rhodomelaceae*
Apiaceae	*Cymodoceaceae*	*Myrtaceae*	*Rosaceae*
Apocynaceae	*Cyperaceae*	*Nelumbonaceae*	*Rubiaceae*
Araceae	*Dennstaedtiaceae*	*Not indicated*	*Rutaceae*
Araliaceae	*Dictyotaceae*	*Nyctaginaceae*	*Salvadoraceae*
Aristolochiaceae	*Ehretiaceae*	*Oleaceae*	*Santalaceae*
Asparagaceae	*Ericaceae*	*Orchidaceae*	*Sapindaceae*
Asphodelaceae	*Euphorbiaceae*	*Oxalidaceae*	*Sapotaceae*
Asteraceae	*Fabaceae*	*Paeoniaceae*	*Sargassaceae*
Basellaceae	*Fagaceae*	*Papaveraceae*	*Saururaceae*
Berberidaceae	*Geraniaceae*	*Passifloraceae*	*Schisandraceae*
Bignoniaceae	*Gleicheniaceae*	*Pedaliaceaae*	*Scrophulariaceae*
Bixaceae	*Gracilariaceae*	*Pedaliaceae*	*Simaroubaceae*
Boraginaceae	*Hydrocharitaceae*	*Phyllanthaceae*	*Solanaceae*
Bryopsidaceae	*Hypericaceae*	*Pinaceae*	*Tropaeolaceae*
Burseraceae	*Lamiaceae*	*Piperaceae*	*Ulvaceae*
Cactaceae	*Lauraceae*	*Pittosporaceae*	*Umbilicariaceae*
Campanulaceae	*Lecythidaceae*	*Plantaginaceae*	*Verbenaceae*
Cannabaceae	*Linaceae*	*Plumbaginaceae*	*Violaceae*
Cannaceae	*Lythraceae*	*Poaceae*	*Vitaceae*
Caprifoliaceae	*Magnoliaceae*	*Polemoniaceae*	*Zingiberaceae*
Caricaceae	*Malpighiaceae*	*Polygalaceae*	*Zygophyllaceae*
Caryophyllaceae	*Malvaceae*	*Polygonaceae*	
Cleomaceae	*Meliaceae*	*Pontederiaceae*	
Clusiaceae	*Meliaceae + Fabaceae*	*Primulaceae*	

Using Knomana to propose plant based solutions

2 approaches

- Navigating = look for an existing solution in Knomana
- Exploring = create new knowledge combining existing ones from Knomana

  e.g. create new sanitary solution (to be evaluated) according to plant active compounds
  => to valorise local plant species, locally unknown for a use

  e.g. fill knowledge gaps respecting the One Health approach
  plant with various heath uses => toxic for human and the environment?

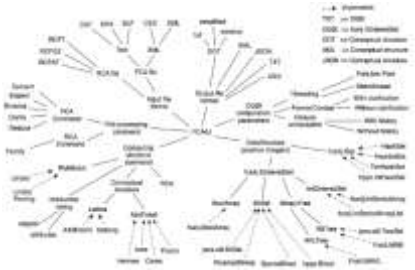
⇒ development of Artificial Intelligence methods

- Supported by

  and the project SmartFCA (ANR-21-CE23-0023/, 900 K€)
- Supervision of a PhD(2018-2021) and many research masters
- 2022: 2 masters student (editor to navigate within knowledge expressed as implications, automatic detection and correction of anomalies)
- Publications and software



RCAviz

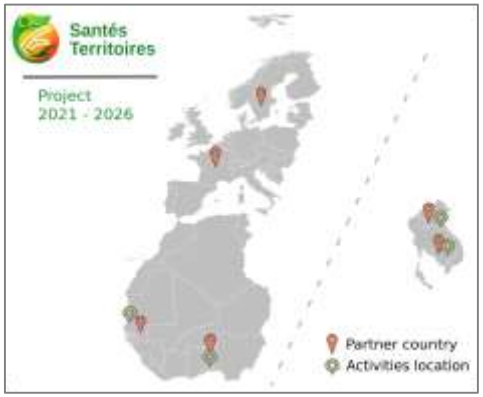


Features of FCA4J software library

Short term Perspective

Santés Territoires

The project Santés-Territoires (2021-2026, EU-AFD, 6 €M)



ISRA, IRD, Stockholm Resilience Centre, IRC, cirad

- Among other activities
  - Conduct a floristic survey and evaluate local plant uses
  - Build a multidisciplinary working group (human, animal and plant health)

=> Establish transdisciplinary plant selection criteria considering, among others, active ingredients, toxicity on human being, and impact on the environment.

A first mobile application release for Senegal under development



=> Propose local plants as alternatives to pesticides, antibiotics, and the most predominantly used plants

Thank you for your attention



@Pierre Martin, Cirad

Gnith (Sénégal) - Mars 2022



St Louis, marché de plantes médicinales (Mars 2022)

@Pierre Martin, Cirad

For more information

Pour en savoir plus



plants

MDPI

Review

Prototyping a Knowledge-Based System to Identify Botanical Extracts for Plant Health in Sub-Saharan Africa

Pierre J. Silvie [1,2,3,*], Pierre Martin [2,3], Marianne Huchard [4], Priscilla Keip [2,3], Alain Gutierrez [4] and Samira Sarter [5,6]

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Abstract: Replacing synthetic pesticides and antimicrobials with plant-based extracts is a current alternative adopted by traditional and family farmers and many organic farming pioneers. A range of natural extracts are already being marketed for agricultural use, but many other plants are prepared and used empirically. A further range of plant species that could be effective in protecting different crops against pests and diseases in Africa could be culled from the large volume of knowledge available in the scientific literature. To meet this challenge, data on plant uses have been compiled in a knowledge base and a software prototype was developed to navigate this trove of information. The present paper introduces this so-called *Knomana* Knowledge-Based System, while providing outputs related to *Spodoptera frugiperda* and *Tuta absoluta*, two invasive insect species in Africa. In early October 2020, the knowledge base hosted data obtained from 342 documents. From these articles, 11,816 uses—experimental or applied by farmers—were identified in the plant health field. In total, 384 crop pest species are currently reported in the knowledge base, in addition to 1547 botanical species used for crop protection. Future prospects for applying this interdisciplinary output to applications under the One Health approach are presented.

Keywords: biopesticides; plant-based products; pesticidal plants; essential oils; crop protection; IPM; natural substances; knowledge management

check for updates

Citation: Silvie, P.J.; Martin, P.; Huchard, M.; Keip, P.; Gutierrez, A.; Sarter, S. Prototyping a Knowledge-Based System to Identify Botanical Extracts for Plant Health in Sub-Saharan Africa. *Plants* **2021**, *10*, 896. https://doi.org/10.3390/plants10050896

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1. Introduction

Crop production is hampered by the action of various organisms: competing plants, vertebrate pests (birds and mammals, including rodents), invertebrates (insects, mites, mollusks, nematodes) and diseases (fungi, viruses, bacteria, phytoplasma), some of which can be vectored by insects. These antagonistic organisms can develop on plants in the field, in greenhouses or postharvest, as well as on seeds or other stored food commodities.

Crop damage in the sub-Saharan region of Africa is caused by indigenous organisms or invasive exotic species [1]. *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is an indigenous species known to be a major cotton pest. Otherwise, the exotic species *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) are major pests of tomatoes and maize crops, respectively [2–4].

The use of synthetic pesticides (insecticides, acaricides, fungicides, nematicides, rodenticides, molluscicides) has also led to direct pest reductions, in turn reducing quantitative and qualitative crop yield losses. The compounds used in Africa are often formulated



Éditeurs scientifiques
J.-P. Profizi, S. Ardila-Chauvat, C. Billot, P. Couteron, M. Delmas, T. M. H. Diep, P. Grandcolas, K. Kokou, S. Muller, A. S. Rana, H. L. T. Ranarijaona, B. Sonke

Biodiversité des écosystèmes intertropicaux

Connaissance, gestion durable et valorisation

Chapitre 46

Le management des connaissances liées aux usages des plantes

Une initiative combinant savoirs traditionnels et publications scientifiques pour l'approche *One Health*

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