Ethnobotanical applications for insect pest managment in stored rice and maize in the Isangi territory, DRC

Jeremy Berdy*[1], Florent Bondekwe[2], Papy N'Sevolo[3], Hossein Azadi[4], Frédéric Francis[5], Marie-Laure Fauconnier[1]

[1]Laboratory of Chemistry of Natural Molecules, Gembloux Agro-Bio Tech, Passages des Déportés 2, 5030 Gembloux, Belgium
[2]Institut Facultaire des Sciences agronomiques de Yangambi, Laboratoire d'agroécologie et d'ingénierie de l'environment avenue Abbé Munyororo n° 750, 9/6, Quartier Plateau Médical C/Makiso, Kisangani
[3]Department of Economics and Rural Development, Gembloux Agro-Bio Tech, University of Liege, Gembloux, Belgium
[4]Ecole Post-Régionale d'Aménagement et de Gestion Intégrés des Forêts et des Territoires Tropicaux (ERAIFT), Université de Kinshasa, B.P. 15.373-Kinshasa, R.D. Congo
[5]Department of Functional and Evolutionary Entomology, Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium

Context

With 26 million people suffering from chronic malnutrition and food insecurity, the optimisation of the agricultural production system in the Democratic Republic of Congo is one of the largest challenges to achieve the global sustainable development goals of 2030. In this regard, post-harvest practices is an essential domain as it covers all downstream operations from the field to the plate. Improving those practices does not only improve food security but augments food safety and quality, optimises resources available and augments significantly the income for the agricultural and commercial actors. In the Isangi territory, most of the agrarian land coverage is dedicated to the cultivation of rice, maize and cassava. The post-harvest processing of cassava is largely mastered by local populations. On the other side, rice and maize, that constitute the main source of income for most of the households is still managed in the most precarious conditions. Local governments, development agencies and Congolese scientists are aware of those challenges, however most agrarian reforms or development projects were focused on preharvest treatment and marketing issues. Consequently, local knowledge and the literature is non-existent about the actual incidence of insect pests in the traditional storage sites in the region. Moreover, the dire logistical and financial possibilities caused the impossibility of implementation of phytosanitary products in the current state of the Isangese agriculture. In this context, the present research evaluated the possibility to implement the valorisation of ethnobotanical knowledge as a tool for reducing post-harvest losses of those cereals.

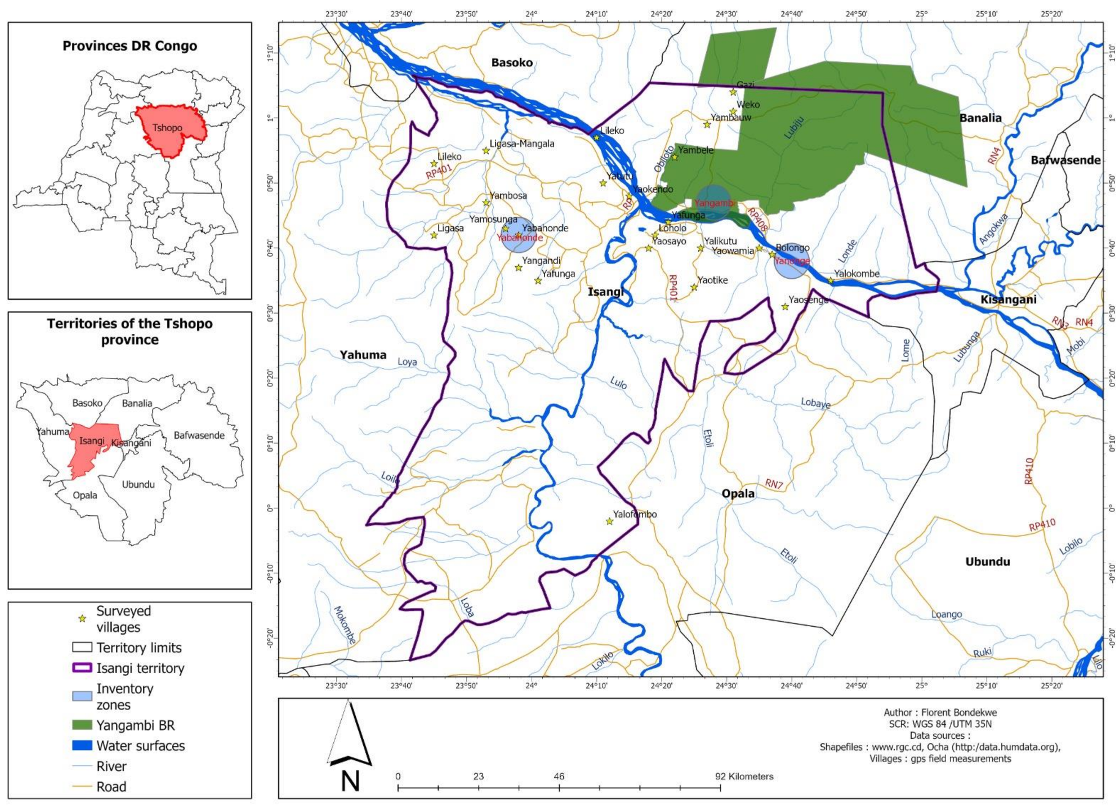


Fig. 1 Map of the Isangi territory, DRC and its surveyed villages and inventoried forests

Methodology

Indirect observations

- Qualitative and quantitative data was collected directly through interviews with the cultivators of the Isangi territory in 20 villages, with a total of 100 participants to describe traditional post-harvest handling of crops
- In each village a focus group session allowed to address community issues and opportunities
- A listing of ethnobotanical practices associated with post-harvest crop protection was established

Fig. 2 Photography of the surveying team deployed in Yamesema, Isangi territory, DRC

Direct observations

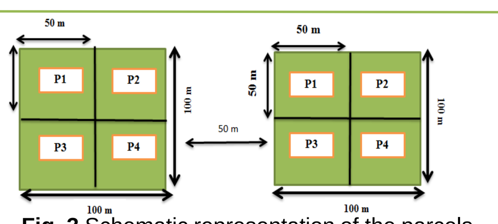


Fig. 3 Schematic representation of the parcels and subparcels setup during floristic inventories

Fig 4&5 Enumeration of germinated maize seeds and *Sitotroga* sp. individuals

- The abundance of the potentially insect repulsive plant species identified during the interview activities was determinated through targeted floristic inventory in 9 parcels in the region
- Over a two-month period, 9 rice and maize storage sites were periodically sampled. The diversity and abundance of insect populations in the harvested rice and maize was assessed.
- In parallel quantitative losses of the stored goods was measured and the variation of qualitative proprieties like apparent insect and or fungal damage and the variation of germinative power was monitored

Results

Table 1 Listing of plant species used as ethnobotanical insect pest management tools

Vernacular name	Species	Organs used	Mode of action
Bofili	*Scorodophloeus zenkeri*	Bark	Repulsive
Nege	*Tetrapleura tetraptera*	Fruits	Repulsive
Café	*Coffea robusta*	Fruits	Repulsive
Pili pili	*Capsicum sp*	Fruits	Repulsive
Alumba lumba	*Ocimum gratissimum*	Leaves, stem, flowers	Repulsive
Timolo	*Solenostemon sp*	Leaves, stem, flowers	Repulsive

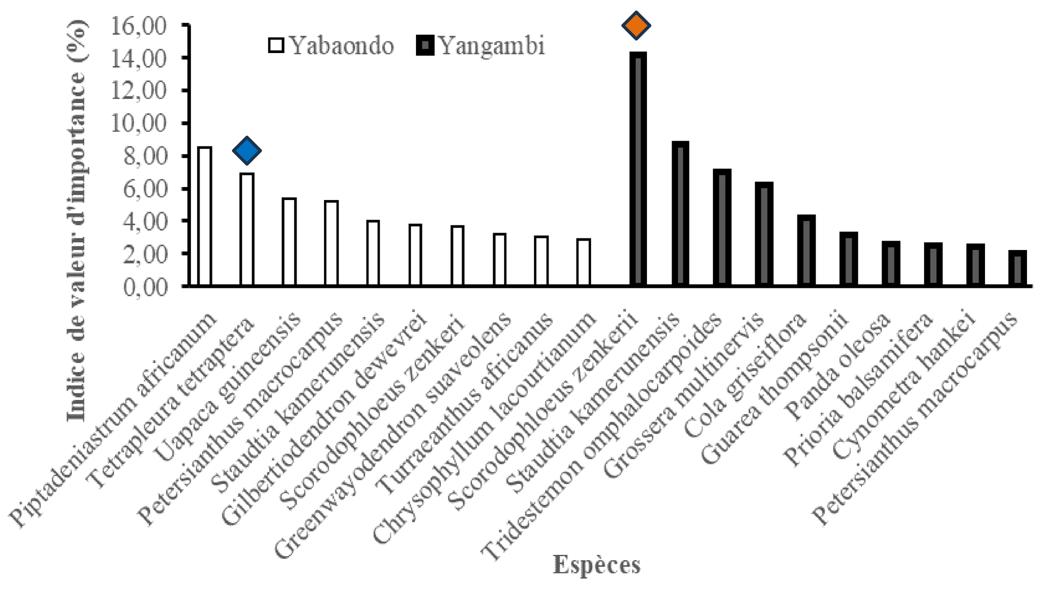


Fig. 6 Relative abundance of inventoried species in the forest parcels around the surveyed villages. Colored lozenge indicate species identified as ethnobotanical repellent against storage pests.

The series of interviews allowed to precisely describe the challenges that the cultivators are facing during post-harvest handling of rice and maize both from a strictly agronomical and socio-economical point of view. Most communities tend to lost all remembrance of ethnobotanics as an effective tool to fight off insect pests. This phenomenon is, to our understanding, caused by the latest evolution of commercial activities and the significant growth of urban centres, which in return polarises the market towards a high economic dependence from the cultivators to sell goods as fast as possible in those consummation hubs. However, some communities still use endemic and imported plant species to mitigate the impact of insect pests on their crops during the storage phase. Listed on **Table 1**, five plants have been identified as potential tools for pest management, all of them are applied in their native form, meaning that plant material is directly placed into the storage bags with the stored good as a repellent. Two of them show encouraging valorisation potential, as shown on **Fig. 6**, as inventoried forests around the surveyed villages contain abundant populations of *Scorodophleus zenkeri* Harms and *Tetrapleura tetraptera* Taub.

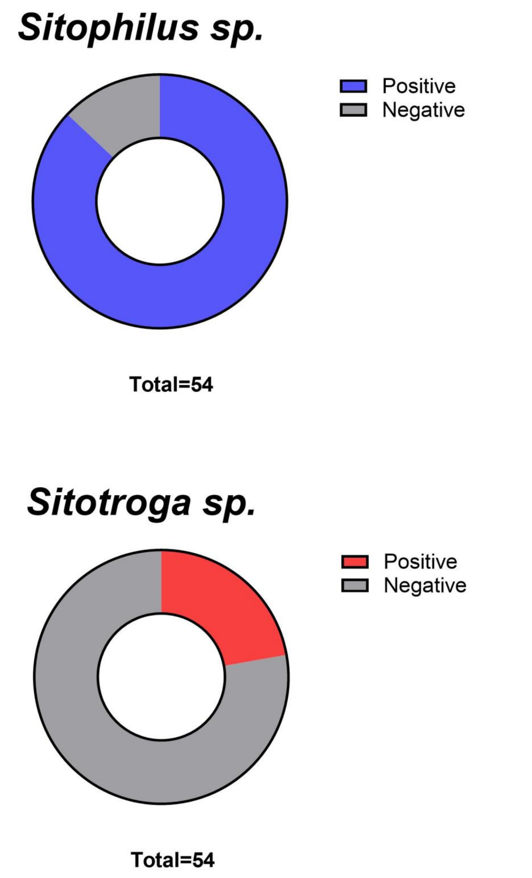


Fig. 9 Proportion of infested samples of rice and maize through *Sitophilus* sp. (blue) and *Sitotroga* sp. (red) in Isangese storage sites

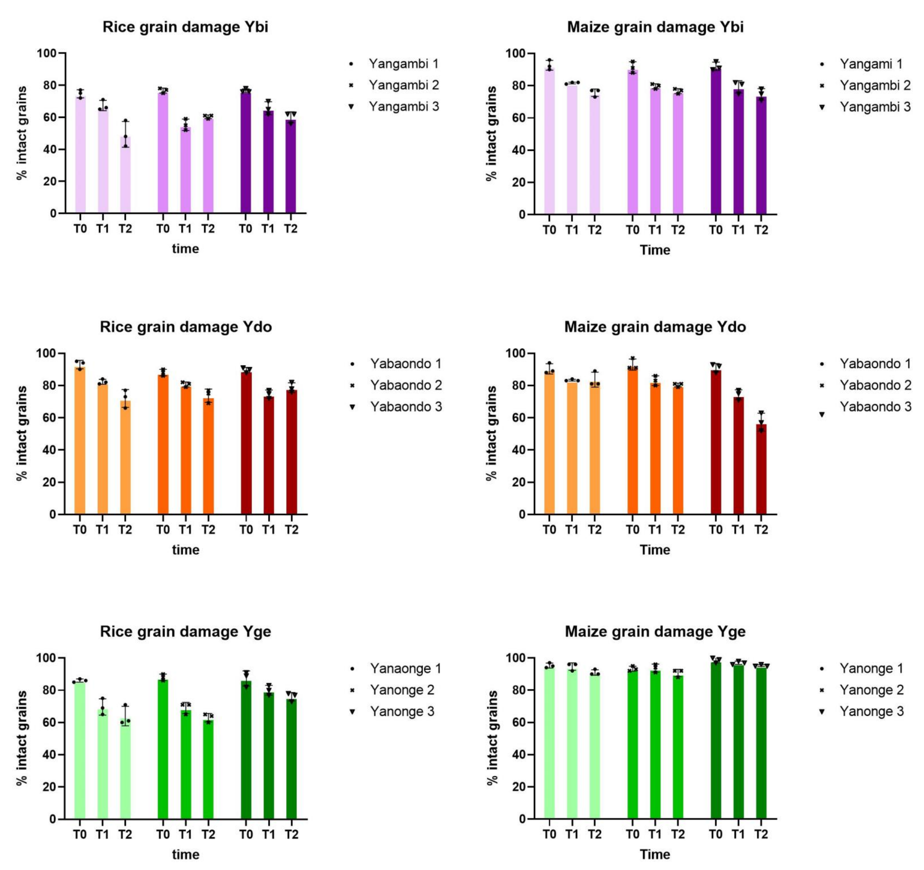


Fig. 7 Evolution of the percentage of intact rice (left) and maize (right) grains over a two-month period in the three main production areas of the Isangi territory: Yangambi (purple); Yabaondo (orange); Yanonge (green)

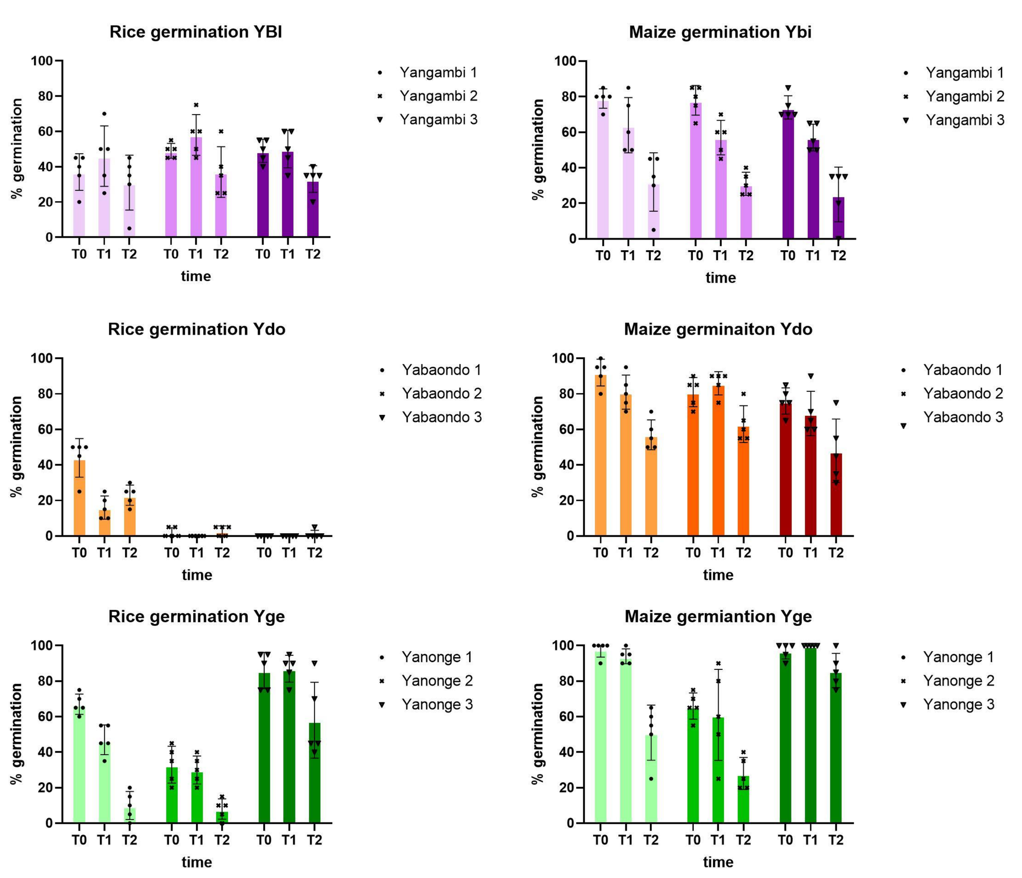
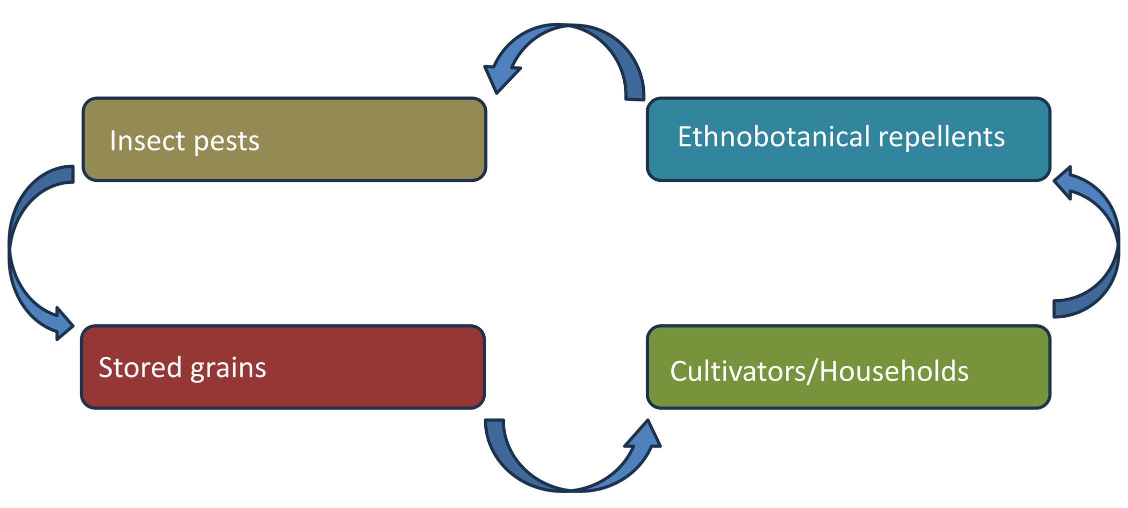


Fig. 8 Evolution of the germination rate of rice (left) and maize (right) grains over a two-month period in the three main production areas of the Isangi territory: Yangambi (purple); Yabaondo (orange); Yanonge (green)

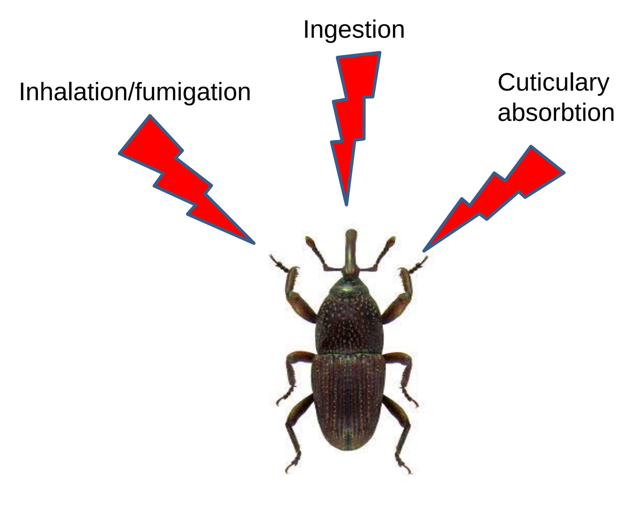
During the two months of monitoring rice and maize grain quantitative and qualitative losses, results show that qualitative losses compared to quantitative losses are the greater risks for the cultivators. **Fig. 7** shows how rice is steadily damaged over time in all three production areas of the Isangi territory, with losses reaching over 20% in the worst cases over this short storage time. Maize grains on the other hand are suffering from acute and isolated damages, as some areas are not significantly affected and other reach almost 40 % loss during the experiment. The evolution over time of the germinative power (GP) of rice and maize seeds as on **Fig. 8** shows how rice initially has a very low GP in the vast majority of the sampled stocks. Over time, this phenomenon is strongly aggravated as most stocks see their GP halved or even divided by up to 6. Maize stocks do start with a better initial GP comparatively to rice. However, the storage environment does not allow its quality to be maintained. Indeed, all samples, with one exception, suffered significant damage after 2 months and the worst cases, observed in Yangambi, did lose three quarters of its GP.

Finally, the research allowed to identify the insect pests partially responsible for the observed losses. As visually demonstrated on **Fig. 9,** weevils are present in almost every sample and grain moth were observed predominantly in samples from the Yangambi area.

Conclusion



In the present state of the research, the frame of the post-harvest losses concerning rice and maize in the Isangi territory could be settled. Indeed, the magnitude of the potential losses have been described and show how qualitative losses, especially of the germination power is a major concern for the cultivators in the region. The proposed methodology allowed to successfully identify the insects mostly responsible for the post-harvest losses in the sampled storage sites. Finally, the floristic inventories in the area pointed out two tree species with high valorisation potential as insect pest repellent due to their abundance on isangese ground. Those findings are of the highest significance given the scarcity of information on the topic in this region and open the way for scientists, development programs and local governmental agencies to shape a new and more efficient way of protecting crops based on local, durable and environment friendly alternatives. However, these advances do not constitute a goal in itself, as the efficiency of those tree species has not been demonstrated in laboratory conditions for their insecticidal or repellent activity. Moreover, those plants haven't been described, to the best of our knowledge, in the scientific literature as a tool for grain pest management and should definitely be studied further.



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For more information, please contact [Jeremy Berdy] ([J.Berdy@uliege.be]).