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Local inhabitants' control strategies of crop pests in Eastern Democratic Republic of Congo, by exploiting the local plant diversity species

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Riassunto. *Gli insetti parassiti costituiscono una grave limitazione per la produzione di cibo nella parte orientale della Repubblica Democratica del Congo. Gli insetticidi sono costosi e non disponibili ai coltivatori. Questi ultimi, pertanto, usano di norma prodotti naturali per tenere sotto controllo i parassiti, impiegando in particolare prodotti di origine vegetale. L'Autore, negli anni 1998-2001, ha effettuato un'indagine sulle piante impiegate dai coltivatori per il controllo dei parassiti. Le piante sono state identificate attraverso ricerche nelle aree rurali, intervistando quattrocento coltivatori. Durante le interviste veniva richiesto di indicare o descrivere la pianta usata, quale parassita controllasse, le dosi e la frequenza di applicazione. L'indagine ha riguardato vari sistemi agro-ecologici nell'area di Kivu (parte orientale della Repubblica Democratica del Congo). Vengono riportate la lista dei parassiti delle colture e la lista delle specie vegetali utilizzate per il loro controllo.*

Abstract. *Pests are serious constraints to food productivity in Eastern Democratic Republic of Congo. Insecticides are also expensive and not available for our farmers. Farmers are currently using natural products to curb the situation. Plants products are commonly used. An investigation of medicinal plants used by farmers to control various pests was carried out during the years 1998-2001. Plants were inventoried through surveys in rural areas. Four hundred farmers were interviewed. During the interview, farmers were requested to explain or describe the plants used, the target pests, the way they formulate their doses and the rate of application during the control of the pests. A team of extension workers/scientist conducted the survey in different agro-ecological zones of Kivu, Eastern DR Congo. As results obtained, the team realised that various plants were currently being used in the control of food crop pests. Lists of crop parasites and plants used for their control are given.*

Key words*: Conservation, Crop pests, D.R. Congo, Medicinal plants, Plant biodiversity, Plant genetic resources*

INTRODUCTION

In Eastern Democratic Republic (DR) of Congo, as in other countries of tropical Africa, beans (*Phaseolus vulgaris* L.), cassava (*Manihot esculenta* Crantz), maize (Zea mays L.), groundnut (*Arachis hypogaea* L.), sweet potato (*Ipomoea batatas* (L.) (Lam.), banana (*Musa* spp.), and sorghum (*Sorghum bicolor* (L.) Moench.) are important food and cash crops for subsistence agriculture grown by 90% of farmers in Kivu area (DR Congo) (MUNYULI, 2000a, 2000b, 2000c, 2000d; MUNYULI, 2002a, b; MUNYULI et al., 2002). They are a primary source of income, vegetable proteins, energy and vitamins for more than 55 million people in DR Congo; and mainly grown during the rainy season at medium and high altitudes (800-3000 m). Yields of these crops vary considerably in different agro-ecological zones. The most

important constraints to food production in this region include socio-economic, abiotic and biotic factors such as low soil fertility, drought stresses, lack of improved varieties, poor marketing and distribution systems, pests and diseases.

Pests are serious constraints to food productivity and production in Eastern DR Congo where they cause significant economic and yield losses (40%) to farmers and to the national economy (MUNYULI, 2001a, b, c, d; BAGALWA *et al*., 1999). The main and effective tactic developed by scientists to control crop pests is use of pesticides. Nevertheless, pesticides are not environmentally friendly and they are not affordable by small scale and low resource farmers. Hence, seeking sustainable and appropriate alternatives such as Integrated Pest Management. Farmers in eastern DR Congo are currently using natural products to curb the situation since they have no economic power to purchase insecticides and limited access to extension works. Plants products (juices, ash, fruits, powders of roots/leaves) are commonly used (MUNYULI & BALEZI, 2001a, b). It was not clear, however, whether farmers considered these constraints as important and be relievable by plant products.

In light of this, a study was conducted in order to ascertain practices and techniques employed by farmers to control crop pests and to inventory and determine the status of botanical insecticides in Kivu area, and thus allow determination of sustainable research priorities focused on the improvement of farmers control methods of crop pests plants.

Fig. 1 - Map of Democratic Republic of Congo.

MATERIAL AND METHODS

Study area

The survey was conducted during the dry and rainy consecutive seasons of 2000-2001 in main zones of crop production of Katana, Minova, Kalehe, Butembo, Kabare, Uvira, Bunyakiri, Walungu and Rutshuru of Kivu province (average population density: 300 inhab/Km², 28°-29° E, 11°-31° S) (see Kivu province on Fig. 1). The climate of Kivu area is tropical humid, type Aw 3. Two main seasons, the long rainy season (September-May) followed by the dry season (June-August) are experienced. The rainfall pattern is bimodal and receives an annual average rainfall, which varies between 1500 and 2100 mm, with average temperatures of 19 °C and a relative humidity of 76% (MUNYULI *et al*., 2000a, b, c, d; CHIFUNDERA, 1998, 2001). The tropical humid climate of the study area is temperate owing to its high altitude which varies between 800 and 3200 m. Permanent settlements are to be found up to an altitude of 2500 m. Subalpine meadow covers all the region and an abundant mosaic vegetation, from typical savannah to mountain forest, grows on the volcanic and ferraltic soils (ferrisoils) (MUNYULI, 2000a, b, c). It has been observed in Kivu area that poverty and the lack of sufficient and well-equipped plant protection systems incited the

population to turn to the traditional medicine to control crop pests.

Selection of interviewed farmers

An investigation of medicinal plants with insecticidal properties used by farmers to control various crop pests was carried out during four years (1998-2001) in Eastern DR Congo. We used lists of all households in each site surveyed. The lists were obtained from chiefs of the villages. Households (70% of the total available in each village) to be interviewed were selected at random from these lists and were visited at their homes and in their fields, fallows, woodlots, and forest patches by investigators. About 3-5 days were spent in each site per cropping season. The number of households interviewed in each site was determined largely by the terrain, social security (ongoing outside war) and cooperation of farmers.

Interview process

A team of 2 extension workers / 2 scientist and 3 technicians from "Centre de Recherche en Sciences Naturelles de Lwiro, Département de Biologie" conducted the survey in different agro-ecological zones of Kivu. They all had experience in such kind of field work.

The questionnaire

The questionnaire adopted in this study was similar to the one developed by Munyuli et al. (2001a, b) on farmers' perception and control practices of crop pests.

The questionnaire addressed crop pest problems experienced during various cropping seasons (rainy and dry season) where applicable and comprised pre- and post-harvest techniques or practices of crop pests control. Wherever possible, the answers were recorded in full. Responses were coded after the completion of the survey at the data analysis stage. In the introductory section of the questionnaire, the respondent's sex and position in the household were ascertained. Respondents were then asked how many years they had been growing staple food crops and whether they had observed any pest problem.

Pre-harvest pest problem

In the pre-harvest section of the questionnaire, farmers were asked to describe (in vernacular names) the pests attacking their crops. A color photo board of the main crop pests was created by investigators in order to facilitate pest identification by farmers. It contained major crop pests identified in the region by several authors (Autrique, 1988; Bagalwa *et al.*, 1999; Munyuli & Balezi, 2001). The board was used to confirm the pest identities only once the farmer had described all of the pests concerning him. This was important as experience has shown that pictures can prompt farmers to name all the insects (and other crop pests: rodents, wild animals) they have seen and not just those causing economic damage. Further information was gathered on control measures used, especially botanicals, and their effectiveness. Wherever possible, farmers were requested to describe the botanicals used and to justify why that choice. Farmers were requested to show samples of botanicals used and the source. Once at the source (gardens, fallows, woodlot, reserves, etc.), investigators collected plant samples. The specimen and seeds/cuttings of the plants were brought to the Centre de Recherche en Sciences Naturelles of CRSN-Lwiro. Seeds were planted and plants kept at botanical gardens of CRSN-Lwiro. Voucher specimen of plants (repellents and insecticides) collected in rural

areas were scientifically identified and stored by reference to the Herbarium of the laboratory of Botany of CRSN-Lwiro, where voucher specimens have been saved since long time ago. More than 400 farmers (300 female and 100 males) from three main tribes were interviewed. There was a gender bias since crop production is mainly a concern of women in Eastern DR Congo. During the interview, farmers were requested to explain or describe the plants used, the target pests, the way they formulate their doses and the rate of application during the control of the pests.

Results

A compilation of plants species used by farmers to control crop pests are listed with their scientific name, family and the vernacular names and the rank number of the targeted pests (Tab. 2). About 20 crop pest species have been recorded and recognised by farmers and translated into English, French and vernacular names (Tab. 1). Plants materials are used singly or in combination. People say that the combination of several ingredients increase the chance of better control of the pest. Moreover, a pest can be controlled by one or more botanicals and one formula can be used to control several crop pests.

Insecticides and repellent botanical recorded belong to several families. The following families are represented:

Agavaceae (2 species), Amaranthaceae (1), Amaryllidaceae (1), Annonaceae (2), Apiaceae (1), Asteraceae (2), Chenopodiaceae (1), Commelinaceae (2), Convolvulaceae (2), Cucurbitaceae (2), Cupressaceae (1), Euphorbiaceae (3), Fabaceae (7), Lamiaceae (7), Liliaceae (1), Meliaceae (1), Myrtaceae (2), Phytolaccaceae (1), Piperaceae (1), Rubiaceae (4), Solanaceae (6), Thymelaeaceae (1), and Verbenaceae (2). According to these data, it appears that Fabaceae, Lamiaceae, Rubiaceae, and Solanaceae constitute 24 of the 53 (45.3%) plants used by farmers to control crop pests (Tab. 2).

All farmers reported pre-harvest pest problems. Several pest species, known to occur in Africa, were identified by farmers. To combat some soil-born pests, farmers could mix several plant species like Tetradenia riparia, Vernonia amygdalina, Nicotiana terbium and Capsicum fruitensis. Leaves of these plant are dried, powdered, then mixed with water and soap before application.

Farmers used ash and plant extracts primarily because they were cheaper and non-toxic and are traditionally perceived as effective control methods. They use several botanicals to protect their crops against pests. Farmers have already domesticated some of these plants, which were recognised to be more effective.

Plant materials (shoots, buds, barks, leaves, flowers, seeds, rhizome and roots) are used in dried or in fresh state. Dried plants are powdered before use; fresh ones are crushed to prepare an extract (decoction, infusion or maceration) or chewed. Soap is added to the insecticide in preparation to make more effective in the case of control pre-harvest pests. As plant materials, farmers use vegetable juice and oils also .

There was a lot of variation for all measures with dosages usually being either inadequate or excessive and rarely as recommended. The powdered botanical leaves used varied from one area to another, depending of the mixture decided by farmer. The dosage varied from 70 g to 260

g powder per kg of beans.

In the Kivu areas, where agriculture/plant protection services are so marginal that 95% of our farmers are accustomed to traditional ways of addressing the issue of pests using plants from traditional medicine, toxicological evaluation of the effective doses must be scientifically investigated. For this, phytochemical screening and biological assays of plants doses (effective ones) must be carried out to display the active principles.

The laboratory work is in progress to evaluate the efficacy of some botanical extracts. Some substances, such as alkaloids, tannins, lignans, saponins, quinnos, phenols, phytoecdysones and various glycosides, have been isolated from several insecticide botanicals and pointed out as substances which are endowed with biological activities (MUNYULI, 2001; CHIFUNDERA, 2001; CHIFUNDERA *et al.*, 1993; CHIFUNDERA 1998).

The present investigations confirm that plant materials are usually used by farmers to control crop pests. Several plant species recorded can be used singly or sometimes in combination with others as people say that the combination of several ingredients of plants increases the chance of controlling pests. By combining repellents and insecticides plants, farmers are trying to take advantage of the synergy of activity of the plants, generated by their combination.

Tab. 1 - Scientific, French and Vernacular names of main crop pests in rural areas of Kivu, DR Congo.

Pest No	Scientific name of the pest	French name	Vernacular name	Products and crops attacked by the pest
1	*Acanthoscelides obtectus* (Coleoptera: Bruchidae)	Bruches du haricot	Karhule we bishimbo	Bean
2	*Acraea acerata* (Lepidoptera: Nymphalidae)	Chenille défoliante	Cisholero c'ébijumbu	Sweet potato
3	*Agrostis segetum* (Lepidoptera: Noctuidae)	Ver gris	Muga	Beans, Cabbages, Groundnut, Potato
4	*Alcidodes leucogrammus* (Coleoptera: Curculionidae)	Charançon zébré	Imuma	Bean
5	*Antestiopsis orbitalis ghesquierei* (Heteroptera: Anthocoridae)	Punaise du caféier	Sinaburumawa kahwa	Coffee
6	*Anthores leuconotus* (Coleoptera)	Boreur blanc du tronc	Muvunyu gwa burhumbwe na matunda	Coffee
7	*Aphis fabae* (Homoptera: Aphididae)	Pucerons noirs du haricot	Kabasi	Bean
8	*Aspava albidomaculata* (Heteroptera)	Punaises des panicules	Mahuma	Bean
9	*Asterolecanium coffea* (Homoptera)	Cochenille farineuse	Nkidabujeri	Coffee
10	*Aulacorthum solani* (Homoptera)	Chenille défoliante	Kabasi ka cirayi	Potato
11	*Brachytrupes membranaceus* (Orthoptera: Grillidae)	Grillons	Cinjerere	Maize, Groundnut, Cassava

Tab. 1 - Continued

Pest No	Scientific name of the pest	French name	Vernacular name	Products and crops attacked by the pest
12	*Busseola fusca* (Lepidoptera: Noctuidae)	Foreuses des tiges et épis	Songosongo	Sorghum
13	*Callosobruchus maculates* (Coleoptera: Bruchidae)	Bruches du niébé	Karhule we nkole	Cowpea, Greengram
14	*Ceratitis capitata* (Diptera)	Mouche des fruits	Nyamwizungurhi	Coffee, Tomato
15	*Cosmopolites sordidus* (Coleoptera: Curculionidae)	Charançon du bananier	Sinaburuma wensina	Banana
16	*Cylas* spp. (Coleoptera: Formicidae)	Charançons de la patate douce	Mbasi z'ébijimbu	Potato
17	*Epilachna* sp. (Coleoptera: Coccinellidae)	Coccinelles	Mahuma byuhu	Beans, Groundnut, Maize
18	*Maruca testulalis* (Lepidoptera: Pyralidae)	Foreuses des gousses	Nyalwuifunya	Bean, Cowpea, Greengram
19	*Megalurothrips sjostedti* (Thysanoptera: Thripidae)	Thrips	Ruhuka	Bean, Tomato
20	*Ootheca mutabilis* (Coleoptera: Chrysomelidae)	Chrysomélidés	Cirombosho	Bean
21	*Ophiomyia spencerella* (Diptera: Agromyzida)	Mouche du haricot	Nsusi	Bean
22	*Phenacoccus manihoti* (Homoptera)	Cochenille farineuse du manioc	Sinaburuma wa mumbarhi	Cassava
23	*Phthorimae operculella* (Lepidoptera)	Teigne de la pomme de terre	Muvunyu gwa cijumba (cirayi)	Potato
24	*Plusia circumflexa* (Lepidoptera)	Chenille défoliante du pois	Cisholero	Peas
25	*Plutella* sp. (Lepidoptera)	Chenille défoliante du choux pommé	Nyalwuifunya we shu	Cabbage
26	*Prophantis smaragdina* (Lepidoptera)	Pyrale des drupes	Muhuka	Coffee
27	*Rhopalosiphum maidis* (Homoptera)	Pucerons du mais	Kabasi	Maize, Sorghum
28	*Rhopalosiphum padi* (Homoptera)	Pucerons du mais	Kabasi	Maize, Sorghum
29	*Schizonica* sp. (Coleoptera: Scarabaeidae)	Les chaf grub du sol	Hombogolo	Cassava
30	*Sesamia calamistis* (Lepidoptera: Noctuidae)	Foreuses des tiges	Songosongo	Maize, Sorghum
31	*Sitophilus oryzae* (Coleoptera: Curculionidae)	Charançon des grains des céréales	Karhule w'ébigonji	Rice, Maize, Sorghum
32	*Sitophilus zeamaize* (Coleoptera: Curculionidae)	Charançon des grains des céréales	Karhule w'ébigonji	Maize, Rice

Tab. 1 - Continued

Pest No	Scientific name of the pest	French name	Vernacular name	Products and crops attacked by the pest
33	*Sitotroga cerealella* (Lepidoptera)	L'Alucite des céréales	Muvunyu gw'emburh o yamagonji	Rice, Maize
34	*Spodoptera exempta* (Lepidoptera: Noctuidae)	Chenilles Légionnaires	Bisholero	Maize, Sorghum, Millet, Wheat
35	*Zabrotes subfasciatus* (Coleoptera: Bruchidae)	Bruches du haricot	Karhule webishimbo	Bean

Tab. 2 - Botanical families, scientific and vernacular names of main species used by Kivu farmers in the control of injurious crop pests. Numbers in the fourth column are those of Tab. 1.

Family	Scientific name	Vernacular name	Targeted crop pests referring numbers[1]
Agavaceae	*Agave americana* L.	Cinusi	31,33,35
	Agave sisalana Perrine	Cinusi	15,25,32
Amaranthaceae	*Amaranthus viridis* All.	Lurhendebuka	15,31,32,33,35
Amaryllidaceae	*Crinum zeylanicum* L.	Kenje	15,35
Annonaceae	*Annona squamosa* L.	Mustaferi	9,10,14
	Xylopia aethiopica A. Rich.	Cinjali	31,32,33,35
Apiaceae	*Centella asiatica* (L.) Urb.	Kurhuiri Kuguma	2,24,30,34
Asteraceae	*Chrysanthemum cinerariaefolium* Vis.	Pirètre	31,33,35
	Tagetes minuta L.	Maua	21,33,35
	Tithonia diversifolia A. Gray	Citokabulaya	20,21
	Vernonia amygdalina Delile	Mubirizi	31,32,33,35
Chenopodiaceae	*Chenopodium ugandae* Aellen	Mugunduzimu	8,23,33
Commelinaceae	*Palisota ambigua* C. B. Clarke	Lugozi lwe muzirhu	15,35
	Palisota schweinfurthii C. B. Clarke	Lugozi lwe muzirhu	15,35
Convolvulaceae	*Ipomoea cairica* (L.) Sweet	Cinvurha-cinjomba	33,35
	Ipomoea involucrate Beauv.	Cinvurha-lurhendazi	33,35
Cucurbitaceae	*Momordica foetida* Schum	Muhu	5,9,17
	Peponium vogelii Engl.	Mukuzo	14,16
Cupressaceae	*Cupressus lusitanica* Lindl.	Cipré	15,31,33
Euphorbiaceae	*Neoboutonia glabrescens* Prain	Lunyambuga	33,35
	Phyllanthus nummulariaefolius Poir.	Cifagiya	16,19
	Ricinus communis L.	Lugaja-Mubonobono	16,19,31
Fabaceae	*Alysicarpus rugosus* (Willd.) DC	Egwerhe	2,15,16,19
	Derris elliptica Benth.	Dolico	20,27,28
	Erythrina abyssinica Lam.	Cigohwa	18,26
	Indigofera spicata Forsk.	Kahwerhe	12,18
	Neorautanenia mitis (A. Rich.) Verdc.	Kahulomba	7,22,26

Tab. 2 - Continued

Family	Scientific name	Vernacular name	Targeted crop pests referring numbers[1]
	Rhynchosia resinosa Hochst. ex Baker	Mumbuti	10
	Tephrosia vogelii Hook f.	Mulukuluku	3,9,11,33,34,35
Lamiaceae	*Acrocephalus galeopsifolius* Baker	Lugangala	33,35
	Haumaniastrum galeopsifolium (Baker) Duvign & Plancke	Mukwa	2,9,11,15,25
	Iboza riparia N. E. Brown	Irago	31,32,35
	Mentha aquatica L.	Shayona-Shununu	30,33,35
	Ocimum gratissimum L.	Kahengerehengere	25
	Ocimum lamifolium Hochst.	Kahengerehengere	1,25,33,35
	Tetradenia riparia (Hochst.) L. E. Codd	Mutuzo	22,31,35
Liliaceae	*Aloe lateritia* Engl.	Cizimyamuliro	23,25,34
Meliaceae	*Entandrophragma angolense* C. D. C.	Cishonja	15,33,35
Myrsinaceae	*Maesa lanceolata* Forsk.	Mbarhi	15,31,32,33,35
Myrtaceae	*Eucalyptus* sp.	Akaliptusi	15,31,32,33,35
	Psidium guajava L.	Ipera	5,11,15
Phytolaccaceae	*Phytolacca dodecandra* L'Herit.	Cimpokolo-Muhokolo	12,14,17,18,30,34
Piperaceae	*Piper guineense* Shum & Thonn	Muborobondo	3,34
Rubiaceae	*Cinchona ledgeriana* Bern. Moens	Kankina	15,33,35
	Pavetta micrantha Bremek.	Nyakahavu	31,32
	Pentas longiflora Oliver	Nakalehe	11,17,26
	Pentas zanzibarica Vatke	Cishanji	5,17
Solanaceae	*Capsicum frutescens* L.	Lushenda	21,24
	Datura stramonium L.	Ntobololo	6,8,10,11
	Nicotiana tabacum L.	Irhabi-Mugombo	3,11,17,34
	Physalis peruviana L.	Mfarha	25
	Solanum aculeastrum Dunal	Mulunda	19,21
	Solanum dasyphyllum Schum & Thonn	Mulenda	14,25
Thymelaeaceae	*Gnidia kraussiana* Meissn	Ntimbiri	22
Verbenaceae	*Clerodendron myricoides* R. Br.	Mukuzaakanyena	5,6,12,14,26,27,28,34
	Clerodendron rotundifolium Oliver	Cinyakulu	6,14,33,34,35

[1] As outlined in Tab. 1.

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