Overview on the use of fallow and rotation crop for nematode management in banana cropping systems

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Some definitions…

- Fallow
  - A practice dating from ancient times. Basically, the term fallow refers to land that is ploughed and tilled but left unseeded during a growing season.
  - Agricultural land that is plowed or tilled but left unseeded during a growing season. Fallowing is usually done to conserve moisture. www.geographic.org/glossary.html
  - Previously cultivated land kept free from crops or weeds during at least one growing season. www.ppathw3.cals.cornell.edu/glossary/Defs_F.htm
  - Land left without a crop for one or more years. A very basic way to improve the soil fertility. www.lethamshank.co.uk/glossary.php

Some definitions…

- Crop rotation
  - A system of farming in which a regular succession of different crops are planted on the same land area, as opposed to growing the same crop time after time (monoculture). www.ncs.org/ehc/glossary.htm
  - The practice of growing several different crops on the same land in successive years or seasons. Usually practised to replenish soil, and curb pests and diseases. www.biobasics.gc.ca/english/View.asp
  - The practice of alternating different crops in a field in planned cycles in order to regulate nitrogen levels, prevent soil erosion, reduce fertilizer needs and improve the overall long-term productivity of the land. www.sustainable.org/intro/dicyionary

References on fallow and crop rotation in bananas in some databases

keywords :	Google Scholar®	ISI® (1991-2006)	MUSALIT
Crop rotation	23,700	1,967	
+ Musa/banana	609	3	10
+ nematode	219	128	
Fallow	16,400	3,944	
+ Musa/banana	612	19	12
+ nematode	141	168	

Some of the requested qualities…

- A good cultivated fallow plant must have…
  - A quick growth to suppress weeds and control erosion
  - An important biomass that decomposes fast
  - A deep root system with a good ability to fix nitrogen
  - An acceptable cost-benefit ratio (including subsidies) based on banana monoculture
- A good cultivated fallow plant must be …
  - Easy to establish (seeds), manage and destroy
- A good cultivated fallow plant must not be …
  - host of the banana key pests (nematodes, insects, viruses)
  - noxious as an invasive weed species into cultivated areas

Some of the requested qualities…

- A good rotation crop must be…
  - Easily integrated in the existing cropping systems
    - existing of specific agro-industrial lines ?
    - existing of specific commercial market ?
    - compatible with the farm size ?
  - Easily integrated in the habits of the growers
    - "know-how" and materials to grow it
  - Totally acceptable from the cost-benefit ratio based on banana monoculture
- A good rotation crop must not be …
  - host of the banana key pests (nematodes, insects, viruses)

Different types of fallow practised by banana growers in Martinique

- An abandoned field : most growers are reluctant to pay for a fallow !
- A spontaneous or weed fallow after mechanical destruction of banana plants.
- A spontaneous or weed fallow after chemical + mechanical destruction of banana plants and volunteers.
- A cultivated fallow (non-host crops) after chemical + mechanical destruction of banana plants and volunteers.

Bare-fallow

- Loos, 1960 (Jamaica):
- Tarjan, 1961 (Florida) : 6 months
- Edwards,1964 (Central America): 5-7 mths
- Salas et al., 1976 (Panama)
- Sarah et al., 1983 (Ivory Coast): 10-12 mths
- Sarah, 1990 (Cameroon)

Weed-fallow

- Salas et al., 1976; Milne et al., 1976 (Panama & Republic of South Africa)
- Zem et al., 1983 (Brasil)
- Sarah, 1989 (Ivory Coast)
- Mateille et al., 1992 (Ivory Coast)
- Chabrier et al., 2003 (Martinique)

Cultivated fallow

- *Crotalaria* sp (Wardlaw,1961)
- Guinea grass + Siratro (Colbran, 1964)
- Pangola grass (Smith et al., 1969; Stoyanov, 1971; Roman et al., 1973
- Soudan grass (Milne et al., 1976; Ternisien et al., 1989)
- Horse bean (Zem et al. 1983)
- Jarra digitgrass (Hall et al., 1993; Pattison, 2006)

Rotation crop

- Sugarcane (Loos, 1960; Smith et al., 1969; Stoyanov, 1971; Pattison, 2006)
- Rice (Salas et al., 1976)
- Cassava (Zem et al., 1983; Price, 1994)
- Eggplant (Melin et al., 1988)
- Pineapple (Sarah, 1989)
- Sweet potato (Price, 1994; Achard, unpublished)
- *Amaranthus* sp (Achard, unpub.)

Major facts in nematode-banana managements during the last decade

- Loss of important non-fumigant nematicides
- Continuous spread of *Radopholus similis* to non infested areas/regions throught infested plant materials
- Only one new homologated nematicide (fostiazate)
- Absence of still effective alternative (biological control) to nematicides
- Increased disponibility of Cavendish banana vitroplants
- Increased awareness of the importance of the weeds as nematode reservoirs
- Improvement of the banana chemical-destruction prior to fallow settlement (shift from 2.4 D to glyphosate)
- Increased concerns related to nematicide applications for environmental quality (product, soil, water) and human health.

Nematode management in high-intensity commercial banana growers

- Exclusion, quarantine and diagnosis
- Pre-plant management just prior to planting
- Treatments at-planting
- Post-plant treatments
- Inter-cycle management between successive banana crops

Exclusion, quarantine and diagnosis

Exclusion of the burrowing nematode, *R. similis* from the planting materials : the most effective and economical mean of preventing nematode damage !

Achieved through : the respect of quarantine regulation, adequate diagnosis and the use of nematode-free vitroplants on non-infested lands.

Pre-plant management just prior to planting

Post-plant treatments

Guying and propping with Bamboo poles and/or polypropylene ropes

Treatments at planting

For the record

Corm coating with nematicides

Post-plant treatments

Fumigation *(for the record)*

Application of granular nematicides

Inter-cycle management between successive banana crops

- "The removal of banana land from production for more than 2 years is not economically feasible. Nematode reduction by fallow would only be practical where bananas are part of a rotation system with crops not host of *R. similis.*" *Salas et al., 1976*
- "Fallowing is practised in parts of West Africa where there is available land…Where bananas are grown continuously, i.e. Latin America, or where it would be uneconomic to leave land fallow, i.e. the Caribbean, crop rotation is generally not practised." *Gowen & Quénéhervé, 1990*

Inter-cycle management between successive banana crops : the Martinique experience

- "In the French West Indies, nematode control in the large commercial banana plantations is currently based on the sanitation of the contaminated banana fields, using chemical destruction of existing banana plants and replanting with nematode-free banana plants produced by tissue culture" *Chabrier & Quénéhervé, 2003.*
- This inter-cycle management has already extended the field longevity from 3-4 to 6-10 years.
- Some formerly contaminated banana fields from Martinique, after a rotation with pineapple or sugarcane are now totally freed from *R. similis* (about 50% of the banana acreage in Martinique, c.a. 4,000 ha).
- Reduction of 63 % in nematicide-insecticide applications (from 84 t in 1996 to 30 t in 2004 for the same banana acreage) *Chabrier et al., 2005*.

Conditions of adoption of these IPM methods on bananas

- Crop rotation is usually not practised because of the high cost of planting and maintaining (irrigation, fertilization, weed and pest management) the rotation crop along with the inability to develop marketable rotation crop.
- Cultivated fallow (cover crop) may only be feasible in high rainfall areas.
- As a consequence, crop rotation is the most widely practised method of disease control worldwide in agriculture …excepted in bananas !

Only incentive actions can force banana growers to adopt these methods !!!

Conditions of adoption of these IPM methods on bananas

- Governmental incentives measures
  - Incentive measures from the Ministry of Agriculture (*Direction Régionale de l'Agriculture et de la Forêt*)
    - operating subsidy for the use of vitroplants
    - operating subsidy for a 1-year fallow period
  - Regulations from the Ministry of Agriculture (*Direction Générale de l'Alimentation, sous direction de la Qualité et de la Protection des Végétaux*)
    - homologation or ban of pesticide for specific use on banana
- Non-governmental incentives measures
  - Through certification procedures

International •independent of agro-industrial lines	**Certification ISO** (ISO 9000; ISO 14001)
International •dependent of agro-industrial lines •dependent of NGO's	e.g. EUREPGAP e.g. (SAN) Rainforest Alliance Certified, Max Havelaar, Fair Trade,
National •independent of agro-industrial lines •dependent of agro-industrial lines	e.g. AB & IGP Labels Banane de Martinique, Banane Planteur