Case Study

Vetiver Grass as Component of Integrated Pest Management Systems

Johnnie van den Berg
School of Environmental Sciences and Development,
North-West University,
Private Bag X6001, Potchefstroom, 2520, South Africa
Email: Johnnie.vandenberg@nwu.ac.za

EXTENDED ABSTRACT

Vetiver grass technology, in its most common form, is the establishment of a narrow (less than 1 m wide) live stiff grass barrier, in the form of a hedge across the slope of the land (Grimshaw, 2003). On its own, like any other pest control method, vetiver will not be effective in reducing pest infestation levels over time. However, vetiver should be seen as a component of Integrated Pest Management **(**IPM) systems. In these systems it could have a role as trap crop for specific pests and as refuge for natural enemies of many different pest species. Good agricultural management practices that ensures good crop health forms the basis of crop protection.

Integrated pest management has been defined as a pest management system that utilizes all suitable techniques and methods in as compatible a manner as possible to maintain pest populations at levels below those causing economic injury. The objective of IPM is the optimization of control in terms of the overall economic, social and environmental needs of mankind. This approach to pest management is aimed at managing pests within ecosystems and not at pest eradication.

Research on insect - vetiver grass interactions and the possible role of vetiver as trap crop in IPM systems was stimulated by the recent development of a novel pest management strategy for stem borers in East Africa (Khan *et al*. 1997, 2001; Midega *et al*., 2005). Trap cropping as pest management tool has received a lot of attention over the past decade (Hokkanen, 1991; Van den Berg, 2006; Glas *et al*. 2007).

Crop pests are a threat to food security in many developing countries. Yield losses caused by Lepidopterous stem borers in Africa can be as high as 80 % for maize and 58 % for sorghum. Lepidopterous stem borers are also the most important pests of rice in the world and annual losses of 10% can result from Lepidoptera damage to this crop.

The burden of managing these pests and general farming activities is usually the responsibility of women who form the majority of farmers in developing countries. Pest control technologies is often too expensive and beyond the reach of these farmers. Development of user-friendly technologies that also has a wider impact on sustainability is essential if we want to improve the livelihoods of farmers in developing countries. Habitat management techniques such as trap cropping and habitat diversification can provide useful technologies with a wider impact than just pest control. Vetiver grass technology, known for its soil conservation properties, should also be appreciated for its multipurpose role in the bigger agro-ecosystem and its more specific role as component of integrated pest management systems.

This presentation describes the results of crop protection research conducted over the past few years on vetiver grass and its use in pest management.

Lepidopterous Stem Borers of Maize

Chilo partellus (Lepidoptera: Pyralidae), is a very important pest of sorghum and

maize in Ethiopia, especially in the eastern semi-arid Amhara region. The two most damaging lepidopteran maize stem borers in the African region are *C. partellus*, an Asian species that invaded Africa during the 20th century and *Busseola fusca* (Lepidoptera: Noctuidae), an indigenous species.

Intensive research has been done on the trap crop characteristics of vetiver grass. A trap crop is planted in close proximity to the main crop with the aim of attracting target pests away from the main crop. Vetiver has the most important characteristics of a trap crop, i.e. it is highly attractive to the target pest. Furthermore, since vetiver has the additional quality that it allows no or very low larval survival (Van den Berg, 2003, 2006), it could actually be termed a dead-end trap crop (Shelton & Nault, 2004) for certain pests in certain environments.

Methods used for evaluation of vetiver as trap crop are described in full by Van den Berg *et al*. (2006).

Vetiver grass may have a role as tool in IPM of graminaceous crops throughout Africa where certain pest species occur. Several of the important Lepidopterous pests of crops belong to the Pyralidae family that *C. partellus* also belongs to. Many Pyralidae moths exhibit similar oviposition behaviour and lay eggs on op leaf surfaces from where larvae migrate to feeding sites after egg hatch, just like *C. partellus* does. The possibility therefore exists that vetiver could also be attractive for these pests. Many *Chilo* spp., including the notorious *C. partellus*, which attacks rice in many parts of the world (Van den Berg *et al*., 2003).

Arthropod Diversity and Beneficial Insects on Vetiver

Concerns regarding the status of vetiver grass as host or refuge to insect pests and diseases of other crops have been raised by the National Research Council (1993) and Dafforn (1996). No extensive study has been conducted on the insects that occur in vetiver grass refugia. Personal observations show that many insect species occur on this grass. It can be said this plant species provides shelter, not only to a few potential insect pests, but also to a large number of general predators and parasitoids of insects that occur in the agro-ecosystems where vetiver grass is planted.

To investigate this issue research was started on the diversity of arthropods in vetiver grass refuges and adjacent maize crops. A D-vac was used to sample insects that occur on maize plants and in vetiver hedges surrounding maize fields. Arthropods that were collected were grouped into the following guilds: visitors, beneficials, herbivores and others.

The diversity of arthropods was higher in vetiver than in maize during both the summer and winter samplings. The numbers of insects collected during winter was much higher on vetiver than maize. This shows that vetiver is refuge to many arthropods during the winter- or off-season after harvest when the crop environment does not provide shelter and/or food any more. The Coleoptera complex in vetiver consisted largely of beneficial insects such as the Coccinellidae (ladybirds). Arachnida (spiders) were collected in small numbers on both plants species. These results are however not conclusive since the study was only done over a short period. Many years of data is needed on arthropod ecology before conclusions on the role of host plants as refugia can be made. More research on this topic is being conducted.

Vetiver hosted large numbers of visitors (mainly Diptera flies) and herbivores during winter. These herbivores were mainly Hemiptera and Homoptera (sucking insects). The high diversity and numbers of insects in vetiver during the winter sampling indicates that vetiver possibly functions as a refuge for many species that cannot survive in maize fields after the onset of winter.

Vetiver as Insect Repellent and its Effect against Termites

Anecdotal evidence exist that vetiver roots *per se* is repellent to insects. Vetiver roots for example are used to repel clothe moths, head lice and bed bugs. Scientific reports do however exist of repellent compounds present in vetiver oil extracted from roots of vetiver grass. Vetiver oil is a complex essential oil that consist of several hundreds of compounds (Zhu *et al*., 2001) of which six are reported to possess insect repellent properties (Jain *et al*., 1982). The latter authors, in bioassays with vetiver oil, found it to have topical irritant activity on cockroaches and flies. Zhu *et al*. (2001) indicated that one of the chemical compounds in vetiver roots, nootkatone, was a strong repellent and toxicant to Formosan subterranean termites (*Coptotermes formosanus* (Isoptera: Rhinotermitidae)) in the United States of America and suggested planting of a barrier of plants that manufacture a termite repellent could potentially provide repellence to this pest.

Vetiver Grass Technology and Pest Management

The role of vetiver grass technology in control of pests should not be seen in isolation of other pest management tactics. On its own, like any other pest control method, vetiver will not be effective in reducing pest infestation levels over time. Vetiver should be seen as one of the components of IPM systems. In these systems it could have a role as trap crop for specific pests and as refuge for natural enemies of many different pest species. A good agricultural management practice that ensures good crop health forms the basis of crop protection. Selection of suitable crop varieties, correct soil cultivation methods, the encouragement of natural enemies and even the judicious use of insecticides all have a role in integrated pest management. A trap crop such as vetiver together with good management practices could contribute significantly towards sustainable pest management. An increased understanding of the influence of plant- and associated arthropod-species diversity on pest populations will lead to the development of recommendations for utilizing vetiver grass and its associated arthropod-diversity as resources for pest management.

Vetiver grass technology for soil erosion management is already applied in countries where stem borers are important pests of maize. In Costa Rica, vetiver grass is used principally as conservation hedge for the protection of maize (Rojas 1997). Similarly, vetiver grass technology was introduced and adopted by many farmers in east and southern African countries such as Zambia, Zimbabwe, Tanzania and South Africa (National Research Council 1993). In terms of pest management application, this benefit would however only be realised if the optimum spatial arrangement of the vetiver grass trap crop is determined to exploit its attractiveness under field conditions.

Benefits of Vetiver Technology in Agriculture

Using vetiver technology as part of agro-ecosystems can have many advantages and positive spin-offs:

- *Food security*: reduced pest damage to crops will result in increased yields.
- *Soil conservation*: soil erosion and low fertility are common problems in developing agriculture. Vetiver technology protects soils.
- *Exploiting biodiversity*: vetiver is refuge to natural enemies and other arthropods and the presence of vetiver contributes to biodiversity conservation in landscapes that are often left barren during the off-season.

- *Sustainability*: vetiver as trap crop host natural enemies, conserves soil and improves livelihoods of users, thereby ensuring more sustainable farming.
- *Income generation and gender empowerment*: the contribution of women to agriculture is significant. They are involved in time-consuming activities such as managing animals, cultivating soils and controlling pests. Using vetiver as feed for animals or as by-product in weaving or thatching can contribute to gender empowerment through sales of goods or surplus production.

KEYWORDS: pest management, crops, sorghum, maize

References

Glas, J.J., Van den Berg, J. & Potting, R.P.J. 2007. Effect of learning on oviposition preference of field-collected and laboratory-reared *Chilo partellus* (Lepidoptera: Crambidae) populations. *Bulletin of Entomological Research* 97, 415-425.

Grimshaw, R.G. 2003. The role of Vetiver grass in sustaining agricultural productivity. (http://www.vet .org)(accessed on 24/04/2003).

Jain, S.C., Novicki, S., Eisner, T. and Meinwald, J. 1982. Insect repellents from vetiver oil: Zizanal and epizizanal. *Tetrahedron Letters* 23 (45): 4639 – 4642.

Hokkanen, H.M.T. 1991. Trap cropping in pest management. *Annual Review of Entomology* 36: 119-138.

Khan, Z.R., Ampong-Nyarko, K., Hassanali, A., Kimani, S., Lwande, W., Overholt, W.A., Pickett, J.A, Smart, L.E., Wadhams, L.J. & Woodcock, C.M. 1997. Intercropping increases parasitism of pests. *Nature* 388, 631 – 632.

Midega, C.A.O., Khan, Z.R., Van den Berg, J. and Ogol, C.K.P.O. 2005. Habitat management and its impact on maize stemborer colonisation and crop damage levels in Kenya and South Africa. *African Entomology* 13: 333-340.

National Research Council, 1993. Vetiver grass: a thin green line against erosion. National academy Press, Washington, D.C.

Rojas, M. 1997. Soil conservation and Vetiver grass in Puriscal – Costa Rica. *Vetiver Newsletter* 17: 26 – 27.

Shelton, A.M. and Nault, B.A. 2004. Dead-end trap cropping: a technique to improve management of diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae). *Crop Protection*, 23: 497–503.

Van Den Berg, J., 2006. Vetiver grass (*Vetiveria zizanioides* (L.) Nash) as trap plant for *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae) and *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae). *Bull. Ent. Soc. France* 42, 449 – 454.

Van den Berg, J., Midega, C., Wadhams, L.J. and Khan, Z.R. 2003. Can vetiver grass be used to manage crop pests? In: Vetiver grass – a world technology and its impact on water. Proceedings of the Third International Conference on Vetiver and Exhibition, Guangzhou, China, October 2003. Agric. press, Beijing pp. 262 – 273.

Zhu, B.C.R, Henderson, G., Chen, F., Maistrello L. and Laine, R.A. 2001. Nootkatone is a repellent for Formosan subterranean termite (*Coptoterme formosanus*). *Journal of Chemical Ecology* 27: 523 – 531.

A Brief Introduction to the Speaker

Prof. Johnnie van den Berg is Program Manager: Plant protection in the School of Environmental Sciences at the North-West University in South Africa. He heads a research programmes on habitat management in grain cropping systems and environmental impact of GM crops. He has been awarded the King of Thailand Award for his research on the sue of vetiver grass in crop pest management.