Crop Protection 90 (2016) 142–149

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Managing storage pests of maize: Farmers' knowledge, perceptions and practices in western Kenya

Charles A.O. Midega [a, *], Alice W. Murage [b], Jimmy O. Pittchar [a], Zeyaur R. Khan [a]

[a] International Centre of Insect Physiology and Ecology (icipe), P.O. Box 30772-00100, Nairobi, Kenya
[b] Kenya Agricultural and Livestock Research Organization (KALRO), P.O. Box 25-20117, Naivasha, Kenya

ARTICLE INFO

Article history:
Received 28 March 2016
Received in revised form
27 August 2016
Accepted 30 August 2016
Available online 9 September 2016

Keywords:
Maize
Storage pests
Integrated pest management
Smallholder farmers

ABSTRACT

Insect pests are a key constraint to effective utilization of cereal crops in sub-Saharan Africa (SSA), with damage caused by these pests in the stores of particular concern. Although a number of approaches have been advanced for control of storage pests of maize, uptake remains a challenge, with effectiveness of some approaches being questionable. We conducted a survey in western Kenya among 330 respondents using face to face interviews and focus group discussions to evaluate farmers' practices, knowledge and perceptions of storage pests of maize, and their current practices in managing such pests as a basis for development of efficient integrated pest management (IPM) approaches for the pests. Majority of the respondents stored maize in traditional granaries, with less than 10% of them using modern improved facilities, mainly due to inability to afford these. Majority of the respondents also cited attack of their stored grains by a number of insect pests, causing about 40% grain losses. The larger grain borer, *Prostephanus truncatus* (Horn) (Coleoptera: Bostrichidae), sawtoothed grain beetle, *Oryzaephilus surinamensis* (L) (Coleoptera: Silvanidae), and maize weevil, *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae), were perceived as the most common and damaging pests. Farmers' perceptions of pests were positively and significantly influenced by level of education and farming experience, indicating that education and experience build farmers' understanding of storage pests. Storing maize in unshelled form seemed to result in less pest attack, although majority of the respondents stored their maize in shelled form. Moreover, local maize varieties were perceived to be resistant to pests. The farmers applied various control methods, with sun-drying being the most popular practice. Usage of pesticides was minimal, mainly due to high costs, lack of information, and unavailability of appropriate and effective products. There were also other cultural methods applied, such as use of smoke and insecticidal plants. The respondents decried lack of training and extension services on storage pests and their management, underscoring the need to develop extension services. The underlying mechanisms of the perceived pest resistance in local varieties of maize and cultural pest management methods need to be established for exploitation in development of effective IPM approaches. There is also need to address the challenges hindering uptake of modern storage and control approaches.

1. Introduction

Cereal crops play a major role in smallholder farmers' livelihoods in sub-Saharan Africa (SSA), with maize, *Zea mays* L., being the most important food and cash crop for millions of rural farm families in the region. In spite of the importance of maize in the region, grain yields are generally <1.0 t/ha, representing some of the lowest in the world (Cairns et al., 2013). This, combined with the high human population growth rates, results in a widening gap between food supply and demand, consequently aggravating the chronic food insecurity in SSA, with one in every four people estimated to be undernourished (FAO, 2013).

Among the key constraints to improving food security in Africa are losses resulting from poor post-harvest management of grains, estimated at 20–30%, amounting to more than US$4 billion annually (FAO, 2010). Some of these losses are caused by insects and fungi, with the speed at which these multiply being influenced by prevailing environmental conditions (Nukenine et al., 2010). Fungi attack on maize, for example, results in both qualitative and

* Corresponding author.
E-mail address: cmidega@icipe.org (C.A.O. Midega).

http://dx.doi.org/10.1016/j.cropro.2016.08.033
0261-2194/

quantitative losses, resulting in mycotoxins such as aflatoxin (Tefera, 2012). Insect pests are a key constraint to effective production and utilization of cereal crops in SSA. Indeed, it is estimated that 10–88% of the total maize produced each season in the region is lost due to field and storage pests (Kfir et al., 2002; Ogendo et al., 2004a; Ojo and Omoloye, 2012). While a number of efforts are being implemented to help alleviate ravages caused by field pests (Midega et al., 2015), post-harvest losses resulting from insects remain a huge challenge (Tefera et al., 2010). Directly, these losses result from insect feeding and reproduction. Additionally, stored maize further gets contaminated with the presence and accumulation of excreta, cast skins and cadavers. Indirectly, insect presence and feeding often raises grain temperature and moisture contents, thus creating warm moist spots of increased grain respiration or humidity that stimulate grain deterioration and further fungal activity (Tefera et al., 2010). For many people in SSA, these losses threaten household food security and undermine market returns, driving them to seek options for protecting their grain during storage (Stathers et al., 2008). The favorable tropical climatic conditions and poor storage systems in the region often favor growth and development of these pests, resulting in considerable losses (Bekele et al., 1997). In some instances, farmers are forced to sell their maize grains off cheaply soon after harvesting due to anticipated losses in storage and later buy food at higher prices.

Considering the dual necessity to achieve food security and food safety, especially in developing economies, there is need for simple and effective pest management approaches for smallholder farmers who form the bulk of grain producers in SSA. For that, a number of approaches ranging from cultural to use of pesticides have been advanced for management of post-harvest pests. Reports indicate that judicious use of synthetic insecticides could provide effective pest control (Ogendo et al., 2004b). However, there is growing concern about insect-related food quality problems among consumers, with awareness of the potential hazards from chemical pesticides being on the increase. Furthermore, problems associated with pesticides, and the possibility of misuse of pesticides, and the accompanying undesired effects, demand a vigorous search for alternative pest control practices. There is thus a need to develop integrated pest management (IPM) packages that are suitable and cost-effective for the smallholder farmers' conditions in the region.

In spite of the ravages caused by storage pests, there exists very little information on farmers' perceptions of the pests and their management practices in the region. One of the major constraints upon establishing effective pest management approaches for smallholder farmers is the lack of adequate information about farmers' knowledge, perceptions and practices in pest management (Morse and Buhler, 1997). Indeed, the need to understand farmer knowledge systems has been recognized as a basis for development of pest management technologies that are adapted to local farmers' situations (Van Huis and Meerman, 1997; Norton et al., 1999) and meet their aspirations, as a key condition to adoption of new innovations (Chitere and Omolo, 1993). Moreover, understanding these could significantly strengthen the practical basis for exploring the potential approaches of intervention for more IPM-oriented storage pest management for smallholder farmers in SSA. The current survey was conducted to identify potential points for intervention in the development of IPM strategies for storage pests of maize that are appropriate to the needs and circumstances of low-income, smallholder farmers in western Kenya. Specifically, the study sought to (1) evaluate farmers' knowledge and perceptions of storage pests of maize; (2) examine farmers' current practices in managing storage pests of maize; and to (3) identify pest management challenges and intervention opportunities as a basis for development of efficient IPM approaches that would contribute to attainment of food security and improved incomes by effectively addressing losses attributable to post harvest insect pests in western Kenya.

2. Materials and methods

2.1. Study site

The survey was conducted between August and October 2014 in six sub-counties in western Kenya covering the key maize growing areas in the region. These were Homabay (0° 40′ to 0° S, 0° to 34° 50′ E), Vihiga (0° to 0° 15′ S, 34° 30′ to 35° 0′ E), Busia (0° 1′ to 0° 46′ S, 33° 54′ to 34° 26′ E), Siaya (0° 26′ to 0° 18′ S, 33° 58′ to 34° 33′ E), Bondo (0° 25′ to 0° 2′ S, 34° 0′ to 34° 33′ E) and Migori (0° 40′ to 0° S, 34° 50′ E). These areas are characterized by a bi-modal rainfall pattern, with the main cropping season running from March to August and the short cropping season from October to January. The region is also considered of high potential for agriculture, with medium elevation (1000–1700 m above sea level). The main farming systems comprise cereal crops intercropped with food legumes and integrated with livestock.

2.2. Data collection

In order to elicit a comprehensive understanding of the emic (insider, in this case farmer) perspectives (Sileshi et al., 2008) of maize storage and its constraints, particularly insect pests in western Kenya, we used a combination of farm-level cross-sectional data collected through surveys involving individual semi-structured questionnaire interviews and focused group discussions using methodologies described by Midega et al. (2012). In each area, farmers for the interviews were randomly selected using sampling lists provided by the Kenya Ministry of Agriculture and Agricultural Extension officials in each sub-county. This list was derived from master roll, of the main person involved in farming in the households, maintained by the officials. A total of 330 farmers were interviewed, 55 farmers from each sub-county. The semi-structured questionnaire once drawn up was pre-tested and administered by trained enumerators recruited from the target sub-counties with good knowledge of the areas of study. Each interview began with the enumerators confirming the interviewee was the person responsible for maize handling and storage in the household and explaining the aims of the study. Most of the survey questions were ‘open’, in order to avoid limiting farmers' responses. When a farmer scheduled for interview was away from home, the enumerators rescheduled the interviews to coincide with their time of availability. Information sought included (i) farmers' socio-economic profiles, such as age, gender, education and farming experience; (ii) farm characteristics, i.e. farm size, farm area under maize, maize varieties grown, and yields; and (iii) storage of maize and its constraints, e.g. insect pests and pest control methods. In addition to these, information was sought on training on pest control and ranking of severity of pest attack on stored maize, with each interview taking an average of 30 min. Focused group discussions were conducted through organized community meetings (Midega et al., 2012), where guiding questions were asked to stimulate discussion and generate information on the key aspects of maize storage and its constraints, principally insect pests, their management and challenges the respondents faced. Each meeting took approximately 2 h.

2.3. Data analysis

Survey data were summarized and descriptive data analysis conducted using means, frequencies and proportions using SPSS version 21 (SPSS, 2012). A content analysis for the focused group discussion was done, identifying common themes which were later