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Smallholder farmers' knowledge, perceptions and management of pea weevil in north and north-western Ethiopia

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ABSTRACT

Pea weevil (*Bruchus pisorum* L.) is one of the most serious insect pests of field pea (*Pisum sativum* L.) in Ethiopia. A survey of 400 farmers was conducted in four main pea-growing districts in north and north-western Ethiopia. The objectives were to assess farmers' knowledge and perceptions of pea weevil, to examine their current pest management practices and to identify challenges to pea weevil control, so that participatory integrated pest management for smallholder farmers in Ethiopia can be developed. The results revealed that most (71%) of the farmers surveyed had knowledge about pea weevil and were able to identify damaged seeds based on common visible symptoms of weevil infestation. However, most farmers did not know that pea weevil attacks plants in the field, but rather considered it a storage pest. The results also showed that farmers' cultural practices influence the incidence and spread of pea weevil and that most farmers did not check seed for pea weevil symptoms before planting. Only a minority of farmers (19%) harvested peas early and some harvested late, unintentionally promoting infestation and carryover of weevils. In addition, most farmers (74%) were not aware of the source and means of weevil spread on their farm and some did not clean up fallen and shattered peas during harvesting and threshing. The majority (63%) of the farmers surveyed relied on chemical insecticides, namely actellic dust and phostoxin, to treat harvested peas in storage. However, the results revealed a knowledge gap in that farmers were well aware of the problem of pea weevil, but lacked knowledge of cultural practices affecting pea weevil and of problems in the use of pesticides. This highlights the need for farmer training and for development of participatory integrated pest management methods for pea weevil.

1. Introduction

Field pea (*Pisum sativum* L.) is an important legume crop in Ethiopia, where it serves as an important source of dietary protein for humans. Furthermore, it improves soil fertility through its symbiotic nitrogen fixing ability (French, 2004; Messiaen et al., 2006). It is the second most important legume crop in Ethiopia, after faba bean (*Vicia faba* L.). Ethiopia is not only one of the main producers of field pea, but also one of the centres of diversity of this crop (IBC, 2008). According to a FAO report, Ethiopia produced 327,378 tonnes of field pea and ranked sixth in world field pea production in 2012 (FAOSTAT, 2012). Although there has been an increase in production of field pea in Ethiopia, the average yield is low compared with other field pea-producing countries (FAOSTAT, 2012), mainly due to low yield potential of landraces, poor management practices, insect pests and plant diseases (Ali et al., 2008; Fikere et al., 2010).

Insect pests are one of the main production constraints for field pea in Ethiopia. The pea weevil (*Bruchus pisorum* L.) is known to be an economically important pest that causes considerable crop losses in Ethiopia (Ali et al., 2008; Seyoum et al., 2012) and in most other field pea-growing countries of the world (Clement et al., 2000). Pea weevil was first reported in Ethiopia around the mid-1970s, in the northern part of the country (Abate, 2006), and then spread to other field pea-growing areas, mainly through seed exchange and trading (Teka, 2002; Ali et al., 2008). In hotspot areas of the country, up to 85% seed damage and 59% weight loss have been reported (Teka, 2002; Seyoum et al., 2012). In Ethiopia, field pea and other legume crops are grown predominantly by small-scale farmers and the damage caused by pea weevil has a bearing on the livelihood of these growers.

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Worldwide, the control of pea weevil currently relies predominantly on the use of insecticide spray in the field and on fumigation of harvested peas in storage (Horne and Bailey, 1991; Waterford and Winks, 1994; Baker, 1998; Clement et al., 2000; Seidenglanz et al., 2011). However, pesticides are unaffordable for the majority of small-scale farmers in Africa, where pesticide use is lower than in other parts of the world (Abate et al., 2000). Furthermore, due to increased concerns about the side-effects of pesticides on human health and the environment, there is growing demand to implement integrated pest management (IPM) for grain legume pests (Clement et al., 2000). IPM can significantly contribute to increasing average yield and reducing the use of pesticides (Pretty and Bharucha, 2015).

In Africa, where agriculture is mainly dominated by small-scale growers and characterised by diverse cropping systems, farmers often rely on traditional pest management practices to control insect pests (Abate et al., 2000; Abate, 2006). In order to develop an IPM programme for pea weevil that suits small-scale farmers in developing countries such as Ethiopia, information about farmers' knowledge, perceptions and management of the pest is crucial. Such information is also important in the development of participatory IPM for small-scale growers so that experiences can be shared (Norton et al., 1999). Farmers' knowledge and their pest management practices have been reported elsewhere for different cropping systems and associated pests, e.g. sorghum stem borers (*Busseola fusca* (Fuller)) and (*Chilo partellus* (Swinhoe)) (Tefera, 2004), vegetable insect pests and diseases (Obopile et al., 2008; Okonya et al., 2014), sugarcane stalk borer (*Eldana saccharina* Walker) (Cockburn et al., 2014) and cotton pests (Midega et al., 2012). However, despite its economic importance, such pertinent information is not available for pea weevil. Therefore, the objectives of the present study were to: determine farmers' knowledge and perceptions of pea weevil; examine farmers' current pest management methods; and identify challenges in pea weevil control, in order to develop participatory IPM for small-scale field pea growers in Ethiopia.

2. Materials and methods

2.1. Study sites

The study was conducted in four districts in north and north-western Ethiopia, namely: Yilmana Densa (11°17′N, 37°43′E), Semen Achefer (11°50′N, 37°10′E), Ebinat (12°10′N, 38°05′E) and Farta (11°32′-12°03′N; 37°31′-38°43′E) (Fig. 1). These districts are among the main field pea-growing areas in the country and are hotspots for pea weevil attack (Seyoum et al., 2012). The districts are also known for growing a range of crops, including cereals, grain legumes and horticultural crops.

2.2. Data collection and sampling techniques

The data collection for the study was undertaken from October to December, 2014. It started with an informal, exploratory survey in order to get some basic preliminary information and insights on the study sites and the extent of the problems at hand. Experts in the respective District Bureau of Agriculture, development agents and some selected farmers were contacted and interviewed using a checklist.

Subsequently, a three-stage sampling procedure was used to select farm household respondents for a formal survey. In the first stage, eight potential districts were purposively selected on the basis of production of field pea and intensity of prevalence of pea weevil. The districts of Yilmana Densa, Semen Achefer, Ebinat and Farta were then selected using a random sampling technique so as to spread the selection across the districts and avoid biases. In the second stage, four *kebeles* (Peasant Associations, PAs) were purposively selected from each district using field pea production and degree of prevalence of pea weevil as criteria. The population of each PA was: Kotti 7201, Debre Mawie 9850, Agita Eyesus 11474, Diwaro 8972, Liben Danikura 8349, Denibola 6499, Sankra 17225, Yismala 9149, Gimman 9694, Debir 6483, Weniberoch 9754, Aquha 6437, Qolay Denigors 9377, Tsegur 6235, Kimir Dingay 8618 and Awizet 7820. In the third stage, 25 sample farm households were selected from each PA using a random sampling technique. Therefore, a total of 400 farmers from 16 PAs in the four districts were taken as samples for this study.

A structured questionnaire with different modules on household demographic characteristics, farm characteristics, volume of field pea produced, percentage of harvest damaged by pea weevil, knowledge and perceptions of pea weevil and pest control methods was used. The survey was administered by trained enumerators after pre-testing of the questionnaire for its validity. The household data were supplemented by information obtained from key informant interviews, focus group discussions with selected farmers and personal observations during the field survey.

2.3. Data analysis

Descriptive and econometric tools were used to analyse the data. Comparative statistical tools such as chi square (χ^2) and one-way ANOVA were used to compare the different socio-demographic and farm characteristics, knowledge on pea weevil and pest management practices of farmers across the selected districts. Many economic and agricultural publications show that logit and probit models are alternatives that can be employed to model choices which involve two completely mutually exclusive alternatives, such that when one is chosen, the other is totally left out (Gujarati and Porter, 2009). In this study, a binary logit model was used to estimate the likelihood of knowing about pea weevil. Similarly, Khan et al. (2014) used the binary logit model to determine factors influencing knowledge on Napier stunt disease, and Sharma et al. (2015) used a logit model to study factors influencing the decision to use pesticides in vegetable crops. Empirically, the model for estimating the determinants of probability of farmers' knowledge about pea weevil is described as follows (Verbeek, 2008):

$$\ln[P_x/(1-P_x)] = \beta_o + \sum \beta_i \ X_i \quad (1)$$

where P_x is the probability of an event occurring (1 if the farmer is knowledgeable about pea weevil; 0 otherwise); β_o is a constant term; βi is a coefficient associated with the explanatory variable x_i; and x_i is the explanatory variable.

As the ordinary coefficients from the logit model are not easily interpreted, marginal effects which measure the effect of a unit explanatory variable on the probability of a given outcome or dependent variable are also presented. Following Nyaupane and Gillespie (2010) and Greene (2012), the marginal effects of the continuous variables are estimated as:

$$\frac{\partial E[Y|x]}{\partial x_i} = f(\beta' x)\beta_i \quad (2)$$

where $f(.)$ is the density function corresponding to the distribution function $F(.)$

Marginal effects for dummy variables are estimated using:

$$\Pr[Y=1|\overline{x}.,\ d=1] - \Pr[Y=1|\overline{x}.,\ d=0] \quad (3)$$

where x refers to the mean values of all continuous variables.