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Status of Pea Weevil (*Bruchus pisorum*) in Central and Southeastern Oromia, Ethiopia

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ABSTRACT

Background and Objective: Pea weevil (*Bruchus pisorum*) is an important, field to store insect pest of field peas. Information on the distribution and losses due to *B. pisorum* is insufficient in Ethiopia. This study was conducted to assess the distribution, farmers' knowledge and perceptions, pest management practices, storage structures and quantify losses due to *B. pisorum* in four districts of Central and Southeastern Oromia, Ethiopia. **Materials and Methods:** Through random sampling, 386 representative samples were drawn from the four districts using a multistage sampling technique. Semi-structured questionnaires were used to collect data. A statistical package for social sciences was employed to analyze the data. **Results:** The results revealed that 64, 60, 50 and 56.1% of farmers in Cheliya, Liben Jawi, Munesa and Lemu Bilbillo districts, respectively were not aware of *B. pisorum* as a pest of field pea. More than 50% of the farmers in the study districts did not practice pest management for field peas. There were no significant differences among the study areas and between the storage structures in the mean percentage of grain damage and grain weight losses due to *B. pisorum*. However, grain damage ranging from 0-2.18% and grain weight losses ranging from 0-1.24% were recorded in all the study locations, respectively. **Conclusion:** The current study revealed that there was a lack of awareness in the study areas on insect pests of field peas. Minimum grain damage was recorded in all the study areas. Since the study was a one-season and in limited locations, addressing more seasons and locations is recommended in the future.

KEYWORDS

Bruchus pisorum, grain damage, grain weight loss, field pea, Cheliya, Liben Jawi, Munesa, Lemu Bilbillo

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INTRODUCTION

Pea weevil (*Bruchus pisorum* L.) is an important, worldwide field to store insect pest of field peas causing significant losses[1]. *Bruchus pisorum* is strictly monophagous and univoltine. Females of *B. pisorum* spend some time in the field of field peas before laying eggs, during this time, they feed on pea pollen and become sexually mature in a week[2-4]. After entering the pod wall, the larvae of *B. pisorum* feed the maturing seeds and complete their development in the store, resulting in quantity and quality losses[5]. Damage caused by this pest starts in the field, but most of its damage is caused in stored grains. Adults of the insect leave an exit hole when they emerge out of seeds/grains, after which the grains become unfit for food and seed, diminishing the lucrative export market values of the produce[6]. Moreover, the stored product can be contaminated by toxic alkaloid cantharidine produced by these insects and their excreta are hazardous to humans and animals[7].

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Grain weight loss due to *B. pisorum* reaches a maximum when the larvae are becoming mature. Losses occurred during storage usually depend on the number of weevils remaining in the seed after harvest and on the storage facilities and other practices of the farmers[8]. *Bruchus pisorum* cause losses through grain damage and reducing the germination capacity of pea seed[9]. Seed weight loss of up to 17% and 83% infestation of field peas have been recorded in Northern Ethiopia[8]. The exchange of seeds and trading are believed to facilitate the spreading of this pest[10,11]. Traditional pest management practices are common in both developed and developing countries to curb the damage caused by this insect pest[12,13]. Smallholder farmers usually manage *B. pisorum* by spraying in the field and fumigating the stored peas. For instance, farmers in Northern and Northwest Ethiopia apply insecticides, which are either non-recommended or expired, to control the pest during storage[14]. Nevertheless, frequent use of chemical pesticides has both human and environmental side effects. This necessitates the implementation of safe pest management that can reduce reliance on chemical pesticides and reduce losses[15]. However, prior to planning pest management, it is important to have information on the economic importance of the pest. With this perspective, there is little information on *B. pisorum* in most field pea growing areas of Ethiopia. Thus, there was a need to generate information on the insect's status in some potential field pea growing areas. This study, therefore, presents the distribution, farmers' knowledge and perceptions, pest management practices of farmers on field peas and quantify the types and magnitudes of postharvest losses due to *B. pisorum* in different storage structures, in Central and Southeastern Zones of Oromia Region, Ethiopia.

MATERIALS AND METHODS

Study area: The study was carried out from December 2017 to May 2018 in two selected zones: West Shewa and Arsi, in the Oromia Region, Ethiopia. The districts were Cheliya, Liben Jawi, Munesa and Lemu Bilbillo. Agro-ecologically, all the districts were mid to highland areas with more than 2500 m.a.s.l. These districts were selected based on their potential of field pea production.

Sampling procedures: Representative samples were drawn using the formula of Yamane[16]. The technique comprises three stages: First, four potential field pea growing districts were purposively selected from the two zones. Next, sixteen peasant associations (PAs) from all the districts were randomly selected as representatives of the districts. Lastly, 386 households were contacted for data collection:

$$n = \frac{N}{1 + N\,(e)^2}$$

where, N=Number of field pea producer households, n=Sample size and e=Sampling error with a 95% confidence interval level Hence, with N = 11044:

$$n = \frac{11044}{1 + 11044\,(0.05)^2} = 386$$

Data collection: Data from individual households were collected through semi-structured questionnaires. The questionnaires focused on farmers' knowledge, perceptions, storage types/structures, grain damages due to *B. pisorum* and its management practices. Grain samples were taken from the top, middle and bottom of storage structures and bulked together to make a 50 g composite sample.

Grain damage and weight loss: Insect grain damage and grain weight losses were calculated using the count and weight methods[17,18] as follows:

$$\text{Grain damage (\%)} = \frac{\text{Nds}}{\text{Tns}} \times 100$$

where, Nds: Number of damaged grains and Tns: Total number of grains

$$\text{Grain weight loss (\%)} = \frac{(\text{Wu} \times \text{Nd}) - (\text{Wd} \times \text{Nu}) \times 100}{\text{Wu (Wd} + \text{Nu)}}$$

Where:
Wu = Weight of undamaged seeds
Nu = Number of undamaged seeds
Wd = Weight of damaged seeds
Nd = Number of damaged seeds

Data analysis: Data were analyzed using Statistical Package for Social Sciences (SPSS). Statistics such as chi-square, percentages and frequency of occurrence were used to report the results. The data on percent grain damage and grain weight losses were analyzed using Minitab. These data were square root transformed to normalize the variances. Mean separation was conducted using the least significant difference at p = 0.05 significance level.

RESULTS

Determinants of *Bruchus pisorum* distribution and damage in the study districts: There were significant differences in the sources of seed among the study districts (Appendix 1). In Cheliya and Liben Jawi districts, farmers used their seeds. However, 87% of the farmers in the Munesa district used their seed, only 13% of them used seed from other farmers, seed enterprises and the bureau of agriculture. Similarly, in Lemu Bilbillo district, only few farmers (1.9%) used seeds from other sources whereas the majority (98.1%) of the farmers used their seeds. Farmers in all the study areas did not differ in their knowledge of field pea pests especially of the insect pests such as *B. pisorum* (Appendix 1 and Table 1). There were no-significant differences in the responses given to pest management practices and types of storage structures in all the study areas (Table 2 and 3).

There were grain damage and grain weight losses in all districts except Lemu Bilbillo (Table 4 and 5). In all study districts, grain damage ranging from 0-1.53% and 0-2.18% were recorded in bin and polypropylene (PP) sacks, respectively (Table 4). Similarly, grain weight losses ranging from 0-0.79% and 0-1.24% were recorded in bin and PP sacks, respectively (Table 5). However, there were no significant differences among the study districts or between the storage structures in percent grain damage and grain weight losses incurred (Table 4 and 5).

Table 1: Farmers' knowledge on different pests of field pea

	Response of farmers' knowledge on pests of field pea			
District	Yes (%)	No (%)	P-value	χ^2-value
Cheliya	22.7	22.1	0.951	0.349^{ns}
Liben Jawi	20.2	22.8		
Munesa	27.7	27.0		
Lemu Bilbillo	29.4	28.1		

ns: Non-significant

Table 2: Response of farmers to pest management practices on field pea

	Response to pest management practices on field pea			
District	Yes (%)	No (%)	P-value	χ^2-value
Cheliya	18.9	23.6	0.245	4.16^{ns}
Liben Jawi	18.0	23.6		
Munesa	33.3	24.7		
Lemu Bilbillo	29.7	28.0		

ns: Non-significant

Table 3: Percentage of response of farmers to storage types

	Response to storage types			
District	Bin (%)	Sack (%)	P-value	χ^2-value
Cheliya	18.5	22.9	0.277	3.856^{ns}
Liben Jawi	22.2	22.0		
Munesa	20.4	28.3		
Lemu Bilbillo	38.9	26.8		

ns: Non-significant

Table 4: Percent grain damage due to *Bruchus pisorum* in bin and sack stores

	Percent grain damage in bin store	Percent grain damage in sack store
District	Mean (95% CI)	Mean (95% CI)
Cheliya	0.03 (-8.6685, 8.7205)	0.01 (-1.76331, 1.77989)
Liben Jawi	0.08 (-7.8570, 8.0170)	0.09 (-1.7131, 1.9022)
Munesa	1.53 (-6.759, 9.821)	2.18 (0.588, 3.774)
Lemu Bilbillo	0.00 (-0.11, 11.89)	0.00 (1.32, 4.65)

Means are non-significant by LSD at p = 0.05 and CI: Confidence interval

Table 5: Percent grain weight loss due to *Bruchus pisorum* in bin and sack store

	Percent grain weight loss in bin store	Percent grain weight loss in sack store
District	Mean (95% CI)	Mean (95% CI)
Cheliya	0.03 (-0.3406, 0.4086)	0.01 (-0.19166, 0.20956)
Liben Jawi	0.00 (-0.394847, 0.394847)	0.01 (-0.20796, 0.23272)
Munesa	0.79 (0.437, 1.151)	1.24 (1.062, 1.423)
Lemu Bilbillo	0.00 (0.302, 0.819)	0.00 (0.1274, 0.5045)

Means are non-significant by LSD at p = 0.05 and CI: Confidence interval

DISCUSSION

The results from this study indicated that most of the farmers in all study areas used their seed (Appendix 1). This had greatly contributed to limit the distribution of *B. pisorum* in the areas because the insect was absent in Lemu Bilbillo district but recorded in Cheliya, Liben Jawi and Munesa with minimum damage level. The majority of the farmers were not aware of *B. pisorum*. For example, 64% of farmers in Cheliya and 60% in Liben Jawi did not know field pea pests. Even though 31.4% and 28.2% of the farmers in the both districts responded that they knew field pea insect pests, none of the farmers knew *B. pisorum* as an insect pest of field pea. This agreed with Gebreegziabhe and Tsegay[19] that despite of the field peas' popularity in Ethiopia, the production constraints of the crop, such as pests still need awareness creation.

Despite statistically non-significant, the pest management practices for field peas varied among the study areas. Many farmers in the study districts practiced minimum tillage on field peas unlike that of other field crops. Studies by Quddus *et al.*[20] and Getachew[21] indicated that zero to minimum tillage practices result in a low yield and associated with a maximum insect damage. On the other hand, regular tillage practices contribute to death of larvae and pupae at the end in dead grains and overwintering beetles[22,23].

Bin and PP sacks were the common storage structures in all the study districts. However, the numbers of farmers that used them varied among the districts. For example, in Cheliya district, 18.52% of the farmers used bin while 22.9% of them used PP to store their grains. In Liben Jawi, 22.2% and 22.0% of the famers used bin and PP sacks, respectively. In Munesa and Lemu Bilbillo districts, 20.4% and 38.9% of the farmers used bin, respectively. In the districts, 28.3% and 26.8% of the farmers used PP sacks, respectively. The selection of storage types was based on the purposes of storing the grains, grains for market were mainly stored in PP sacks and grains for food were stored in bins. In the study areas, bin and PP were dominant storage structures. These storage types were among the different storage systems reported in Ethiopia[24,25]. *Bruchus pisorum* and its grain damage and grain weight losses were found in all the districts except Lemu Bilbillo. This was because the results of the samples taken from the district showed that the area was free of the insect at the time of this study.

Appendix 1: Determinants of *Bruchus pisorum* distribution and damage on field pea in the study districts

	District									
	Cheliya (N = 86)		Liben Jawi (N = 85)		Munesa (N = 108)		Lemu Bilbillo (N = 107)			
Variables/determinants	Frequency	%	Frequency	%	Frequency	%	Frequency	%	X^2-value	p-value
Seed source:										
own	86	100	85	100	94	87	105	98.1	32.23*	0.00
another farmer	0	0	0	0	5	4.6	0	0		
market	0	0	0	0	0	0	0	0		
seed enterprise	0	0	0	0	5	4.6	2	1.9		
bureau of agriculture	0	0	0	0	4	3.7	0	0		
Knowledge about the general pests of field pea:										
yes	31	36	34	40	54	50	47	43.9	4.205^{ns}	0.24
no	55	64	51	60	54	50	60	56.1		
Knowledge about the insect pests of field pea:										
yes	27	31.4	24	28.2	34	31.5	37	34.6	0.887^{ns}	0.829
no	59	68.6	61	71.8	74	68.5	70	65.4		
Pest management methods/practices:										
yes	21	24.4	20	23.5	39	36.1	31	28.97	12.72*	0.048
no	65	75.6	65	76.5	69	63.9	73	71.03		
Storage types/structures:										
bin	10	11.6	12	14.1	12	11.1	20	18.7	3.11^{ns}	0.375
sack	76	88.4	73	85.9	96	88.9	87	81.3		
underground	0	0	0	0	0	0	0	0		
plain ground	0	0	0	0	0	0	0	0		

N: Number of field pea producer households, ns: Non-significant, *: Significant and χ^2: Chi-square

This study showed that unlike that of pea weevil's occurrence in most of the study areas with minimum grain damage level, the farmers did not know the insect as a field pea pest. The results in this study depends on the samples that were drawn only from storage, studies that will focus both on sampling flat pods in the field and grains from storage are recommended. Furthermore, awareness creation on the insect's economic importance is also important to limit its distribution in the future.

CONCLUSION

This study revealed that many farmers in the study areas were not aware of *B. pisorum* as a pest of field peas. More than 50% of the farmers in all the study districts did not practice pest management for field peas other than the weeding practices they rarely did. The common storage types recorded in the study areas were bins and polypropylene sacks. The current study also showed that except for the Lemu Bilbillo district, the damage due to *B. pisorum* was recorded in all the study areas. The grain damage and grain weight losses recorded were very low across the study districts. However, because of the economic importance of the insect, awareness creation about the insect helps limit further distribution of the insect through a seed exchange. Since the study was a one-season and in limited locations, addressing more seasons and areas is recommended in the future.

SIGNIFICANCE STATEMENT

The pea weevil (*Bruchus pisorum*) was introduced into Ethiopia more than two decades ago. However, studies on the distribution, perceptions of farmers and damage due to the insect are insufficient in many field pea growing areas despite some studies. This study was thus conducted to assess the distribution and perceptions of farmers on *B. pisorum* and to figure out the size of damage due to the insect. It, therefore, helps to have information on the insect's distribution, understanding of farmers and the damage due it in the study locations.

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