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Report

Bean Weevil *Callosobruchus chinensis* in Stored Soybean and Its Management at Jimma, Ethiopia

Tamiru Shimales*, Tigist Bidira

Jimma Agricultural Research Center, Ethiopian Institute of Agricultural, Research, Jimma, Ethiopia

Email address:

Stamiru8@gmail.com (Tamiru Shimales)

*Corresponding author

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Abstract: Soybean has been growing in various agro-ecologies of Ethiopia since its introduction to the country. Among biotic stresses the production of soybean affected by different field and storage pests. Currently, soybean storage insect pest has been a major concern in different soybean producing countries, including Ethiopia. Assessment was done at Jimma agricultural research center on stored soybean entries and varieties for the precence and absence of the *Callosobruchus* pest. As management method, four different locally available storage materials and one imporve storage bag (PICS) were evaluated. The treatments were arranged in randomized complete block design with two replications. We identified the *Callosobruchus chinensis* as one of the economically important stored soybean pest affecting the stored soybean at Jimma, and its infestation severely increased from time to time. Based upon evaluated storage materials 0.06% to 91.71% weight loss after six months storage duration was recorded. Stored soybean seeds in PICS gave lower grain damage (8.05%) and weight loss (0.06%). Hence, Purdue Improved Crop Storage (PICS) can reduce the infestation of *C. chinensis* and can be used as one component of integrated stored soybean pest management. Further studies are recommended especially on the resistant genotype screening, and development of integrated pest management.

Keywords: Polypropylene Bag, PICS, Weight Loss, Grain Damage, Ethiopia

1. Introduction

Soybean is an important pulse crop that plays role in human nutrition, as a source of oil, animal feeds, and soil fertility improvement. In Ethiopia, soybean is highly grown and many technologies had been generating since its introduction to the country with collaboration regional, national research institutes and with other international institutions/agencies/. To increases the soybean genetic variability and to improve low soybean yield in Ethiopia, over 1000 germplasm has been introduced in the last eight years [1]. In addition to poor performing varieties and other poor agronomic practices i.e. limited application of fertilizers [2], and field and storage pests are one of the factors affecting the soybean production.

Currently, soybean storage insect pest/s has been a major concern in different soybean producing countries, including Ethiopia. Among storage pests, *Callosobruchus* is one of the main biotic production constraints causing considerable loss both in the field and during storage on different legumes. Around twenty (20) species were reported and identified in the genus of *Callosobruchus* as economically important pest of legumes [3]. Among identified species some are cosmopolitan pest species (*C. chinensis, C. analis, C. phaseoli* and *C. maculatus*) and some of them are indigenous to East Africa include *C. aethiopicus, C. cherenensis, C. rhodesianus, C. latitarsis* and *C. nigripennis.*

Till the recent time storage pest on soybean was not a major concern in Ethiopia. However, currently the *Callosobruchus* sp (either the cosmopolitan pest species or indigenous ones) continuously observed and the pest highly infesting the stored soybean germplasms at JARC (Figure 1a, b and Figure 2). *Callosobruchus chinensis* is considered the number one problem in stored soybean and affecting the quality and grain of soybean. The objective of the report is to determien the

wheight loss and grain damge due to *C. chinensis* associated with different storage contaners.

2. Materials and Method

2.1. Description of Study Area

The study was conducted at Jimma Agricultural Research Center (JARC/Melko). JARC is found in Oromiya regional state in Jimma zone, Ethiopia, 360 km to southwest of Addis Ababa. It is located at 07°46''N latitude and 36°47'E longitude with an elevation of 1753 meter above sea level (m.asl) receiving average annual rainfall of 1572mm. The area experience has mean daily minimum and maximum temperature of 11.6°C and 26.3°C, respectively. The major soil type of the center is chromic nitosol and cambiosol of upland and fluvisol of bottom land [4].

2.2. Study System and Insect Assessement

Different soybean genotypes were assessed for the precence and absence of the *Callosobruchus chinensis* in stored soybean germplasms at JARC soybean storage room. During assessemnt the *C. chinensis* damage symtom such as holed grain and sign laid egg and adults were considered (Figure 1).

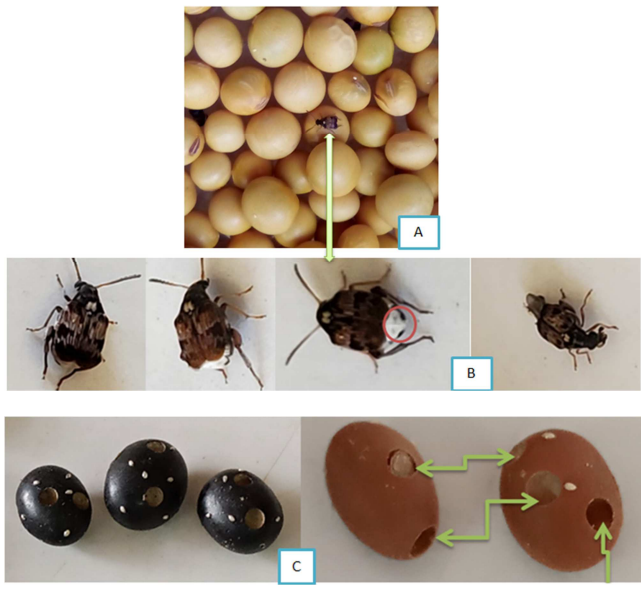

Figure 1. *Callosobruchus on soybean and its damage symptom. A. Adult Callosobruchus feeding on soybean; B. Magnified adult Callosobruchus on soybean (seems female) and C. Adult emergence holes (holes due to adult emerging after pupal stage) three holes per seed. Photograph by Tamiru Shimales, department of plant protection, JARC, 2021/22.*

2.3. Treatments and Design

Four different locally available storage materials and one imporve storage material (PICS) were used to evaluate the impacts of storage materials on grain damage and weight loss at Jimma Agricultual Rsearch Center (JARC). Two soybean varities 'CLARK 63K and COKER/240' were used for the experiment in 2021/22 growing season. The treatments were arranged in factorial way and randomized complete block design with two replications for six months storage duration was used.

Table 1. *Description of treatments.*

No.	Treatment combination
1	*COKER: Plastic bag*
2	*CLARK: Plastic bag*
3	*CLARK: Polypropylene bag*
4	*COKER: P Polypropylene bag*
5	*CLARK: Nylon mesh bag*
6	*COKER: Nylon mesh bag*
7	*COKER: PICS*
8	*CLARK: PICS (Purdue Improved Crop Storage)*

2.4. Grain Damage and Weight Loss Determination

Sampled grains were separated into damaged and undamaged, weighed, numbers counted and percentage weight losses determined using the formula of Adams and Schulter [5]:

$$\% \text{ weight loss} = ((\text{Und} - \text{DNu}) / \text{U} (\text{Nd} + \text{Nu}) \times 100$$

Where "U" is weight of undamaged grain, "Nd" is number of damaged grain, "D" is weight of damaged grain, and "Nu" is number of undamaged grain.

Insect damage was assessed by the count method. Two hundred soybean seeds were randomly taken from each storage containers and the number of insect damaged and un-damaged grains was observed using a hand lens (10x mignification power) for the presence of hole. The percentage of insect damaged soybean seed was then calculated using the formula of Wambugu *et al.* [6]:

$$\text{Number of insect damaged grain} = \frac{\textit{Number of insect damaged soybean grain}}{\textit{Total no of soybean grain}} \times 100$$

2.5. Statistical Analyses

The statistical analyses for percentage of wieght loss and grain damage data were conducted using R v 3.6.3 [7]. For presence and absence of the insect and insect damage discriptive statistics (mean) was considered.

3. Results and Discussion

3.1. Assessement Result

Till the recent time storage pest on soybean was not a major concern in Ethiopia. However, currently the *Callosobruchus chinensis* (cosmopolitan pest) continuously observed pest and highly infesting the stored soybean germplasms at JARC (Figures 1 and 2). Our observation indicated that there was a variation in infestation level among the soybean genotypes. The higher/highest damage level was observed on some stored soybean genotypes/entries at Melko (Tamiru *et al.,* unpuplished data). These data have been not published just a summary of the findings has been reported. The difference in infestation level and grain damage among the genotypes /entry/ might be occurred due to the difference in defense

mechanism the genotypes to *C. chinensis*. This could be the future research works to develop resistant/tolerant/ soybean varieties against storage pests as one component of integrated pest management option.

Figure 2. *A) Multiple adult Callosobruchus; Adult emergence holes (B & C) and Eggs of Callosobruchus (white color).*

Callosobruchus chinensis is a serious economic pest of stored soybean (since 2017 in Ethiopia) and other legumes. At Jimma Agricultural Research in stored soybean germplasms the larvae of bean weevil holes were seen on the stored soybean seed (Figure 2). Previously assessment done on seed lots from 32 PAT locations was identified bruchids and/or bruchid-damaged seed symptom in four countries and although they found *Callosobruchus chinensis* pest species as adult bruchids at the Bwanje and reported no adults in other locations [8]. Moreover, our result showed that adult Callosobruchus (Figure 2) and damaged seed symptom (Figure 2) has been observed on stored soybean germplsams at JARC (Melko) since 2017 and its infestation highly increased from 2019 growing season.

The holed seeds due to bean weevil could reduce the germination viability and also could serve as an entry site for postharvest diseases development. Study indicated that there was a relationship between broad bean weevil (*B. rufimanus*) damage and an increase in fungal contamination [9]. Study shows that germination reduction by bruchid infestation occurs less as a result of damage to the embryo, but mainly as a result of increased susceptibility to fungal pathogens due to injured seed coats [10].

3.2. Wight Loss and Grain Damage

Analysis of variance on grain damage and weight loss percentage showed highly significant difference was observed between storage containers (Table 2). The mean grain damage ranged from 8.05% to 99.54% was recorded due to *Callosobruchus chinensis* after six months of storage duration (Table 2). Similarly, the mean minimum and maximum weight loss from same storage materials and same soybean varieties was 0.06% and 91.71%, respectively.

Stored soybean seeds in Purdue Improved Crop Storage (PICS) after six months gave lower grain damage (8.05%) and weight loss (0.06%) in CLARK 63K soybean variety (Table 2). Similarlly, in same storage container 13.67% (grain damage) and 5.02% (weight loss) was recorded from COKER/240 variety (Table 2). More than 97% of grain damage was recorded from other storage containers and have no significant varition among the three storage cintainers in both varieties (Table 2). However, significant variation was observed in wieght loss among the storage materials see Table 2. Accordingly, the weight loss percentage estimated due to bean weevil in soybean varied among storage containers (treatments) with 0.06% to 91.71% (Table 2). Particularly high grain damge was recorded from CLARK 63K variety stored in Plastic bag (91.71%) followed by COKER/240 variety stored in same storage material (80.51%) as compared to improved PICS storage material (Table 1). Study identify the percentage of insect damage and weight loss was highest in samples stored in polypropylene woven bags, with compared to hermetic technologies [11]. Similarly, other study done on lentil seeds stored in PICS bag and GrainPro super bag had the lowest proportion of seeds with egg or holes per seed than seeds stored either in polypropylene bag or fertilizer bag [12]**.** On the other hand, when PICS used as storage material for soybean grain, grain damage and weight loss due to storage insect pest/s could be reduced.

Table 2. *The impact of storage materials on grain damage and weight loss by Callosobruchus chinensis.*

No.	Treatment combination	Grain damage (%)	Weight loss (%)
1	COKER/240: *Plastic bag*	99.54a	80.51a
2	CLARK 63K: *Plastic bag*	99.36a	91.71a
3	CLARK 63K: *Polypropylene bag*	99.305a	72.83a
4	COKER/240: *Polypropylene bag*	98.70a	43.10abc
5	CLARK 63K: *Nylon mesh bag*	98.28a	53.72ab
6	COKER/240: *Nylon mesh bag*	97.42a	49.07abc
7	COKER/240: *PICS*	13.67b	5.02bc
8	CLARK 63K: *PICS*	8.05b	0.60c
LSD		6.17	52.73
CV (%)		3.4	44.98
	P<0.05 (Variety)	0.05	0.499
P at 5%	P<0.05 (Storage containers)	1.05e-09 ***	0.008 **
	P<0.05 (Variety*storage containers)	0.433	0.691

PICS: Purdue Improved Crop Storage

On stored legume seeds species of *Callosobruchus chinensis* significantly loss in seed weight and grain damge at Jimma (Melko) stored room. Study show that *Callosobruchus* affect the germination viability, weight and the market value of the crop [13], and also reduces the amounts of carbohydrates and proteins of the infested grain [14]. Study done on chickpea indicated that hermetic storage technologies, such as the PICS and SGP bags, effectively suppressed insect development, reduced losses, and preserved seed viability without the need for insecticides [15].

4. Conclusions and Recommendation

The *Callosobruchus chinensis* as one of the economically important stored soybean pest affecting the stored soybean at Jimma, and its infestation severely increased from time to time. Purdue Improved Crop Storage (PICS) can reduce the infestation of *C. chinensis* and can be used as one component of integrated stored soybean pest management. Further studies are recommended especially on the resistant genotype screening, and development of integrated pest management. Further studies are recommended especially on the species identification, genotype screening, host range identification, and development of integrated pest management methods.

ORCID

Tamiru Shimales: https://orcid.org/0000-0002-1286-9227

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Conflicts of Interest

The authors declare no conflict of interest.

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