Vol. 13(2), pp. 19-25, April-June 2021
DOI: 10.5897/JEN2020.0252
Article Number: 481771867038
ISSN 2006-9855

http://www.academicjournals.org/JEN

Journal of Entomology and Nematology

Full Length Research Paper

Preliminary studies on cowpea genotypes resistance to *Callosobruchus maculatus* F. (Coleoptera: Chrysomelidae) in Ethiopia

Mulatwa Wondimu[1], Emana Getu[2]* and Birhanu Amsalu[1]

[1]Ethiopian Institute of Agricultural Research, Melkassa Agricultural Research Center, P. O. Box-436, Oromia, Ethiopia.
[2]College of Natural Sciences, Faculty of Life Sciences, Addis Ababa University, P. O. Box 1176, Ethiopia.

Received 20 March, 2020; Accepted 6 May, 2020

Cowpea is one of the few legumes which adapt well in warm semi-arid and arid climate conditions making it a potential crop for farmers living in dry area of Ethiopia. Since Ethiopia is considered as secondary center of genetic diversity for cowpea, Ethiopian national lowland pulses research program had made effort in the collection of cowpea landraces from different parts of Ethiopia and identified production constraints. *Callosobruchus maculatus* F. was found to be one of the most important post-harvest problems of cowpea production in Ethiopia. During the collections of the landraces, farmers indicated that there were tremendous variations among the landraces in terms of their reaction to C. *maculatus.* These views of farmers guided us to screen cowpea landraces and commercial varieties against *C. maculatus*. Accordingly, 98 cowpea landraces and seven released varieties were screened against the pest. Number of eggs laid, number of holes, percent weight loss and percent germination were the parameters used for the evaluation. The result obtained demonstrated that 45, 13 and 42% of the landraces were resistant, moderately resistant and susceptible, respectively. Bekur and Bole have shown reasonable level of resistance from the commercial varieties. The current findings depicted the existence of high level of resistance in Ethiopian cowpea landraces which could be harnessed in the future cowpea improvement program in general and *C. maculatus* management in particular.

Key words: *Callosoborucus maculatus*, cowpea, landraces, storage.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) is an important grain legume cultivated in sub-Saharan Africa. It is an important high-quality source of protein, especially for resource-poor farmers, who cannot afford animal protein. Its leaves and flowers can also be consumed and processed into hay and silage, resulting in nutritious livestock feed. The cowpea grain contains about 20 to 30% protein, 1-2% fat and 55 to 60% carbohydrates (Sharma and Thakur, 2014). Its high biomass and good ground cover reduce soil erosion and improve soil fertility. Cowpea yields have been characteristically low as a result of both abiotic and biotic stresses. Among the biotic stresses, infestation by *Callosobruchus maculatus* F. at a post-harvest stage mainly in the store is the most important one leading to up to 100% grain losses in 3-6 months of storage period (Lale and Kolo, 2006; Swella and Mushobozy, 2007). Damage by *C. maculatus* include consumption of seeds, loss or conversion of

*Corresponding author. E-mail: egetudegaga@yahoo.com.

nutrients, reduced germination of seeds and contamination with filthy materials composed of insect fragments, exuviae, excreta and molds (Ileke et al., 2013). Farmers try to minimize damage by *C. maculatus* through insecticide application, use of cold storage and different cultural practices that include mixing with small seeded grains like teff, disposal of infested grain and cleaning of store using traditional methods and/or fumigation among others. Though these efforts significantly minimizes *C. maculatus* infestation, losses due to the pest calls for more efforts to keep the pest below economic injury level. A number of scholars found resistant genes in cowpea genotypes elsewhere and in Ethiopia (Gatehouse, 2008; MARC, 1995, 1996; MOA, 2000). However, the number of genotypes tested was few and it was impossible to get genotypes with sufficient level of resistance (Gatehouse, 2008; Mbata, 1993; Redden et al., 1983). Moreover, landraces have more resistant genes than improved varieties due to genetic erosion in improved varieties (Painter, 1951; Taylor, 1981). Hence, the current project was designed to identify genotypes with high level of resistance to *C. maculatus* from landraces and improved varieties which can serve in the future cowpea improvement program in Ethiopia.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Melkasa Agricultural Research Center, Entomology Laboratory from February to May 2018. Melkasa is 110 km away from Addis Ababa to the East. The Center is located in the Central Rift Valley of Ethiopia at 8° 24' N and 39°21' E at an elevation of 1550 m above sea level (m.a.s.l.). The experiment was conducted at 50-70% R.H and 28.4 and 14°C average maximum and minimum temperatures, respectively (MARC, 1995, 1996; Tsion et al., 2009).

Genotype selection

Currently, there were 324 cowpea landraces collected from different regions of Ethiopia. Of these, 98 landraces were randomly selected and considered for the experiment. As standard check, seven released cowpea varieties were included in the experiment. Hence, 105 cowpea genotypes were used for the experiment. As all of the genotypes had few seeds which were not sufficient for the experiment, seed multiplication of the genotypes was made before starting *C. maculates* screening experiment by planting each genotype in the field on 10 m length single row. At harvest, multiplied seeds were stored at -4°C in deep freeze for two weeks to disinfest the seeds from internal infestation. Before the bruchid screening trial started, seeds of cowpea were planted in the field for seed multiplication. The disinfested seeds were put in the laboratory where the experiment was to be conducted for acclimatization for three days.

Rearing and inoculation of bruchids

To obtain the same age group and required numbers of adult bruchids for the experiment, C. *maculatus* was artificially reared at Melkasa Agricultural Research Center (MARC) Entomology Laboratory. The bruchids used for rearing were collected from MARC stores and reared in three small bags having 5 kg capacity each (5 m height × 5 m diameter). About 100 *C. maculatus* unsexed adults were added to each small bag since the sex ratio (male: female) was 1:1. Rearing was done at the room temperature of 25–29°C and relative humidity of 60–70% (Ileke and Olotuah, 2012; Kanaji, 2007). Frequent inspection of the culture for progeny emergence was carried out daily starting from 22 days after parent *C. maculatus* introduction following Bhardwaj and Verma (2012) methods. The newly emerged one-day old adult F_1 progenies were used for the experiment (Bhardwaj and Verma, 2012). Accordingly, 5 male and 5 female F_1 progeny adult were transferred to each transparent 200-ml capacity jar. For the experiment, 50 seeds of cowpea were added to each jar. The jars were covered with open screw caps having muslin cloth to prevent *C. maculatus* from escaping. The beetles were allowed to mate for seven days at 27 ± 1°C and 60 to 90% relative humidity to mate and lay eggs after which they were removed.

Experimental design and data collection

The experiment was designed in a completely randomized design in three replications. Data collection started immediately after parent *C. maculatus* adult were removed from the experimental jars. Data on number of seeds with eggs, number of progenies emerged and number of holes per damaged seeds was taken. Moreover, percent weight loss and germination test were done 90 days after seed storage.

$$\%\text{Weight loss}= \frac{(WuXNd)-(WdXNu)}{WuX(Nd+Nu)}x100$$

Where:
Wu = weight of undamaged seed; Wd= weight of damaged seed; Nd = number of damaged seed; Nu= of undamaged seed.

Data analysis

Data were analyzed using different computer software including R and Microsoft excel. Data were checked for normality before analysis and all data were found to be normally distributed.

RESULTS AND DISCUSSION

Cowpea landraces and the released varieties were clustered into three using number of holes, number of eggs, percent weight loss and percent germination (Figure 1). Variations among the genotypes in terms of number of holes per total seed (NHTS) were significantly (P=0.0001; R= 0.9) high such that genotypes in cluster 1 had about 18 holes, genotypes in cluster 2 had about 25 holes and genotypes in cluster 3 had about 40 holes. Genotypes having the highest number of holes per total seed had the highest weight loss and number of eggs and had the lowest percent germination. Total number of adult *C. maculatus* emerged from cowpea genotypes as shown in Figure 2. The highest number of *C. maculatus* (120 adults) emerged from the landraces though there were landraces with the lowest number of *C. maculatus*.

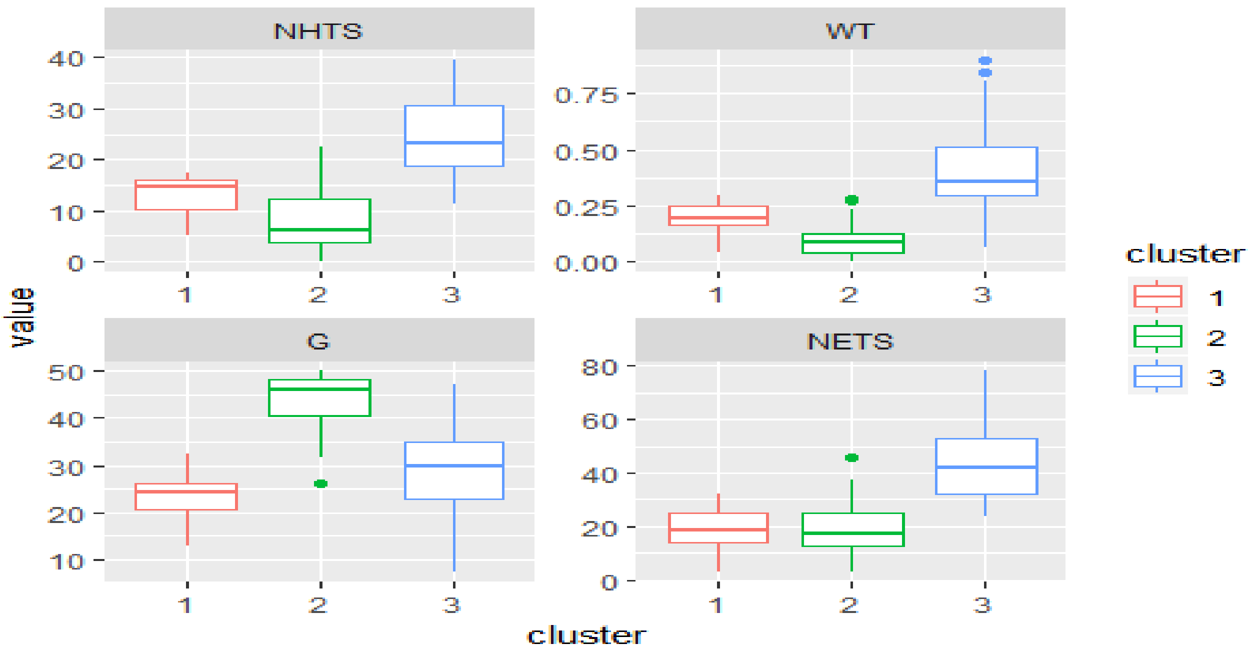

Figure 1. Response of land races to *C. maculatus* using number of holes, number of eggs, percent weight loss and percent germination. NHTS = Number of holes per total seed; Wt = Percent weight loss; G = Germination percentage; NETS = Number of eggs per total seed.

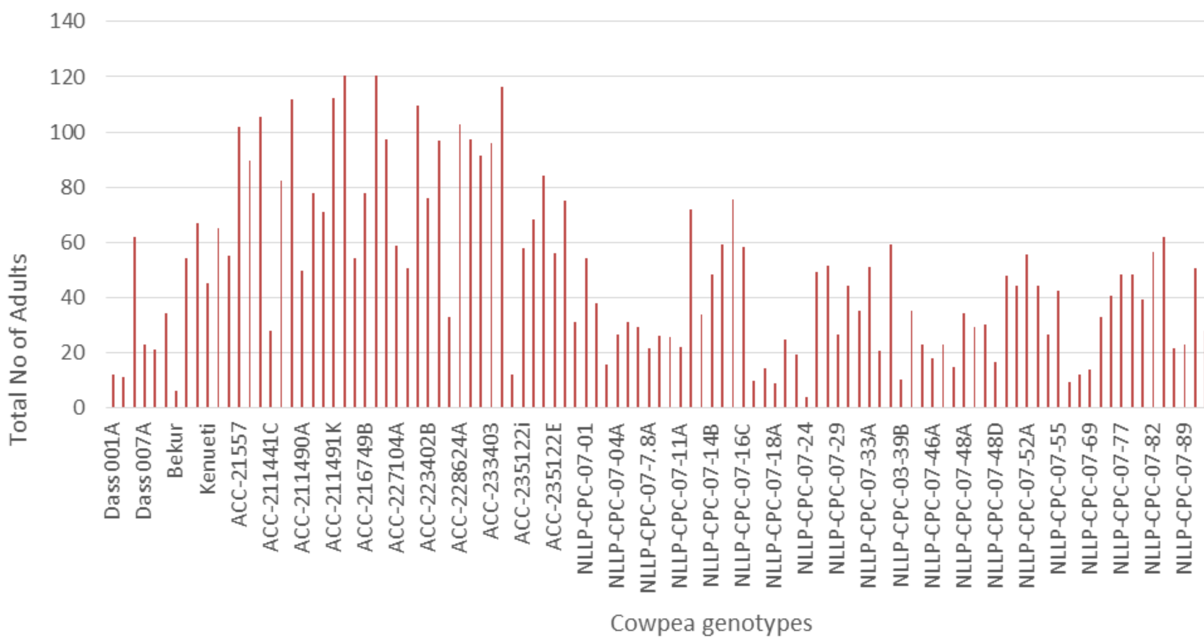

Figure 2. Total number of adult *C. maculatus* from cowpea landraces.

From the released cowpea varieties, the lowest *C. maculatus* emerged from Bekur. About 13 cowpea landraces and one released variety showed the lowest average and total adult *C. maculatus* (Figure 3). No adult emerged from landrace NLLP-CPC-07-77B, while landraces NLLP-CPC-07-72 and NLLP-CPC-07-01 had below 2 average and total adult emerged *C. maculatus*. Bekur released cowpea variety had 3 and 6 average and

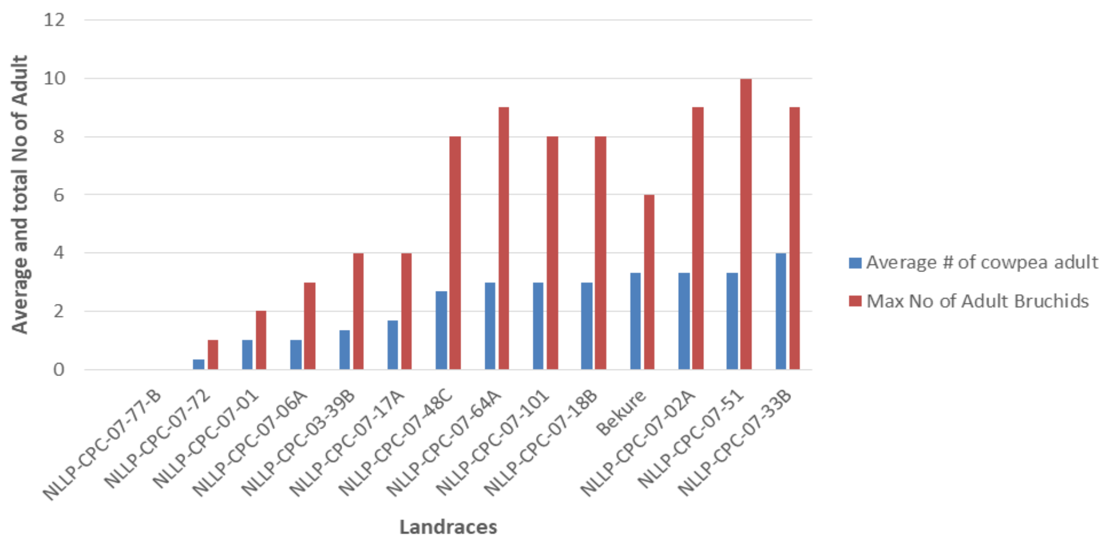

Figure 3. Cowpea genotypes having the lowest average and total emerged adults of *C. maculatus.*

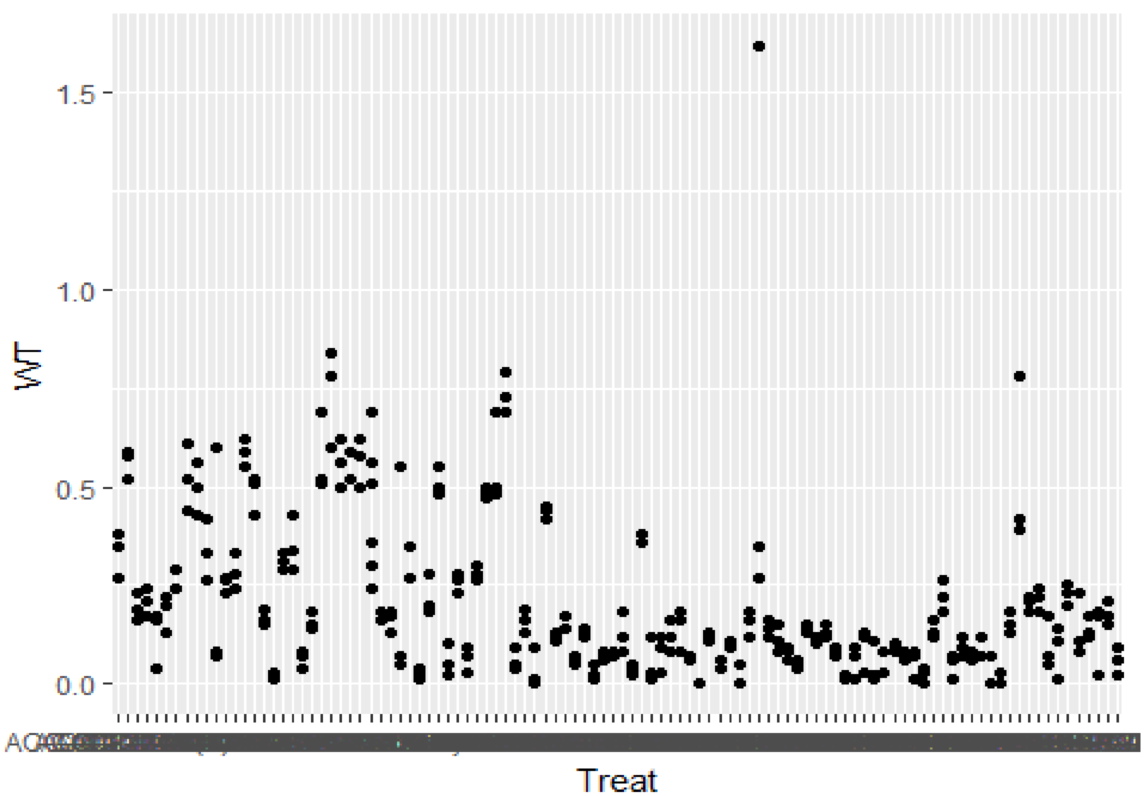

Figure 4. Scattered diagram where the dependent variable is weight losses due to *C. maculatus* and the independent variables are the different cowpea genotypes (treatment).

total adult emerged *C. maculatus*, respectively. Figure 4 demonstrated the correlation of cowpea genotypes with respect to weight losses due to *C. maculatus*. Except few out layers, most of the genotypes tested had the lowest percent weight loss due to *C. maculatus*.

Figure 5 depicted the correlation between number of holes and germination percentage. As number of holes per seed increases, the germination percentage decreases. The correlation of all parameters was demonstrated in Figure 6. Germination percentage was

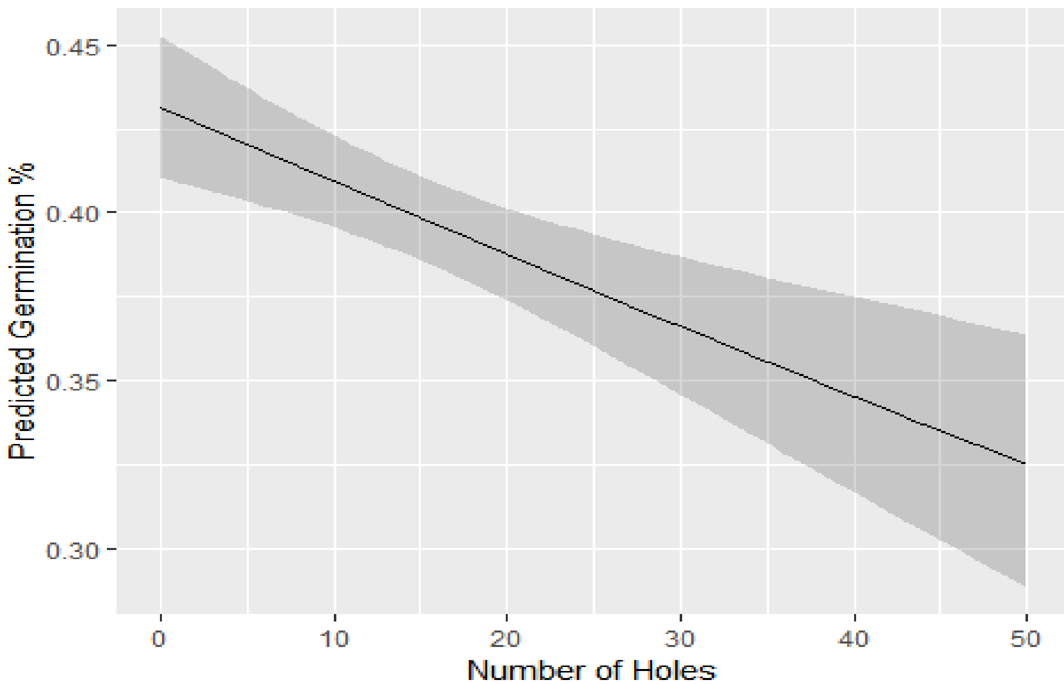

Figure 5. Correlation between number of holes and germination percentage.

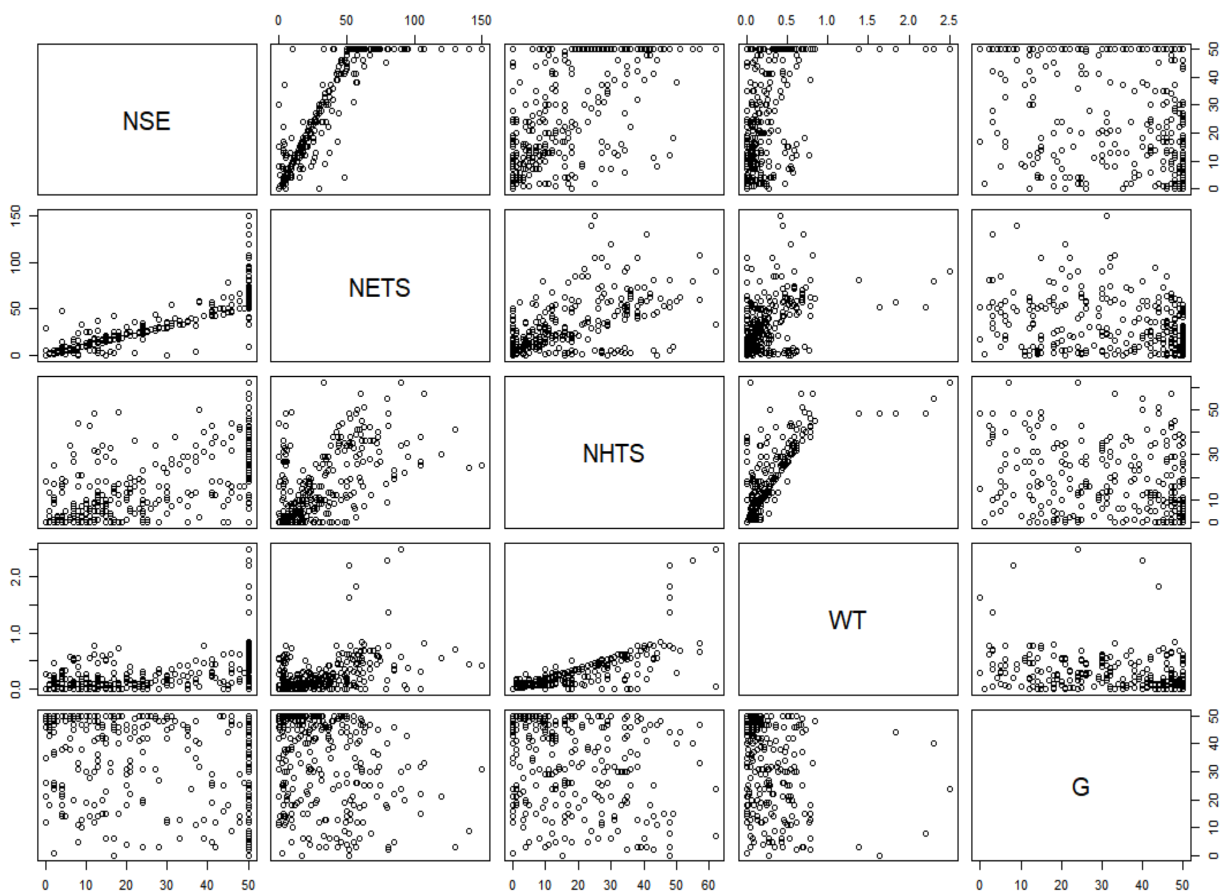

Figure 6. Correlation of all parameters. NSE = Number seeds with egg; NETS = Number of Egg per total seed; NHTS= Number of holes per total seed; WT = weight loss; G = germination percent.

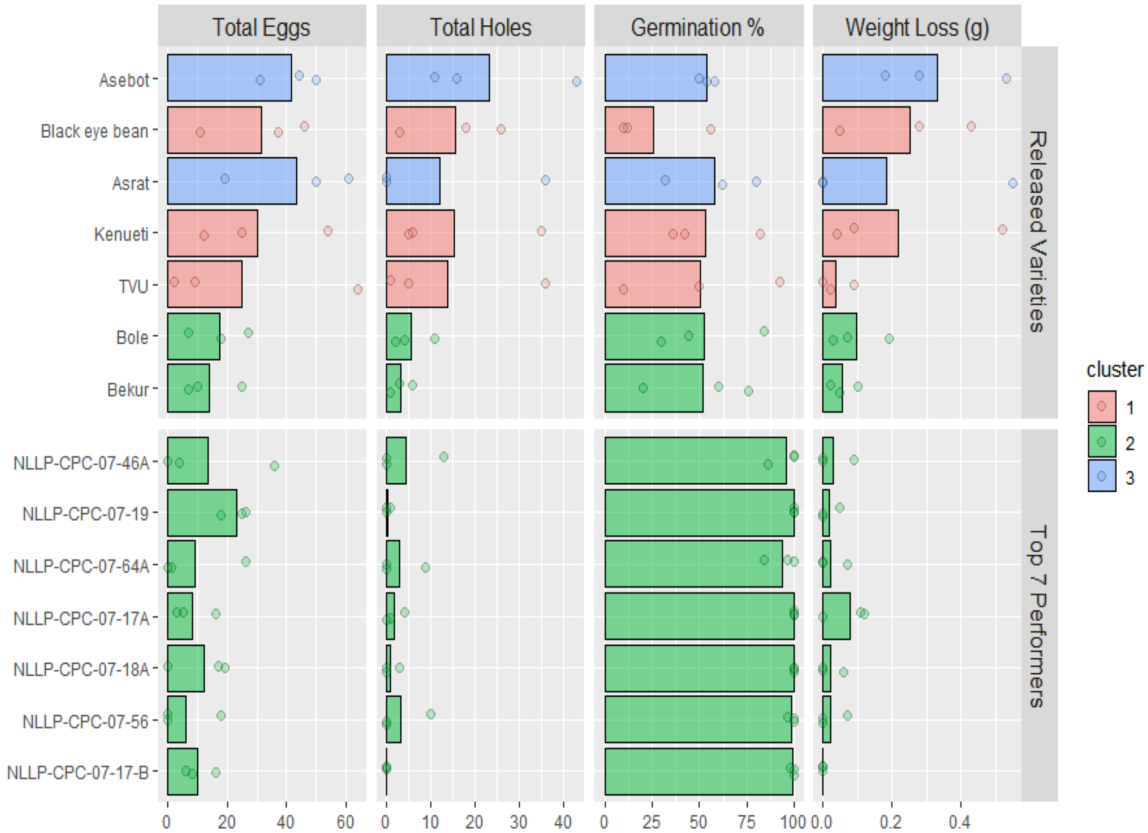

Figure 7. Comparison of performance between released varieties and best performing Landraces in trial.

negatively correlated with the number of holes, number of seeds with eggs and percent weight loss. The performance of the genotypes was clustered into 3 (Figure 7). With most of the parameters such as total number of eggs, total numbers of holes, germination percentage and percent weight loss, the landraces were better than the improved varieties. Total numbers of eggs were the lowest on the landraces except NLLP-CPC-07-19 which was comparable with some of the improved variety like TVU. Total number of holes was significantly low in the landraces than the improved varieties. Most of the landraces had the highest germination percentage. Percent weight loss was the least on the landraces when compared with the improved varieties.

The current experiment demonstrated the presence of high level of variations among the cowpea genotypes in terms of their reaction to *C. maculatus*. The 105 genotypes tested against *C. maculatus* were clustered into 3: resistant, moderately resistant and susceptible. About 45% of the genotypes were found to be resistant implying that cowpea genotypes have sufficient genes responsible to overcome the attack by *C. maculates*. Painter (1951) described host plant resistance as genetically inherited qualities in the plant that determine the ultimate degree of damage done by a pest. Plant resistance to storage pest in general and *C. maculatus* in particular is driven by some mechanisms or principles which involve antibiosis and antixenois (Dugje et al., 2009). Plants have natural barriers such as trichomes, hairs and seed hardness among others which help them protect themselves from attack by insect pests (Cortesero et al., 2000). In both cultivated and wild cowpea relatives, many morphological characters were found to be associated with pest none-preference properties. For instance, the dense and long trichomes on some cowpea cultivars were found to increase their resistance to the pod borers and also to the pod sucking bugs (Bennett and Wallsgrove, 1994). Dugje et al. (2009) reported that resistant cowpea genotypes to *C. maculatus* had rough seed coat, while the susceptible ones have smooth seed coat which is in line with the current findings though data were not included in the manuscript. Variations with the number of eggs laid by *C. maculatus* in the current experiment could be due to variations in the tested genotypes in the seed texture. Another host plant interactions mechanism is the biochemical bases which is very important in insect pest resistance mechanism (Bennett and Wallsgrove, 1994). A number of scientists isolated different groups of chemicals including non-protein amino acids, cyanogenic glycosides, alkaloids, terpenoids, tannins, lignin, and flavonoids that negatively affect the physiology or behavior of *C. maculates* from cowpea. Though it needs further investigation, variations seen in terms of number of progenies recorded on the different genotypes could be due to the presence of one or more phytochemicals in some of the genotypes and absences in the other or vice-versa.

From the current experiment, it can be concluded that both improved varieties and landraces of cowpea genotypes demonstrated high variability in terms of resistance to *C. maculatus* which could be explained both by physical and biochemical mechanisms that should be verified with future work.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Bhardwaj A, Verma SC (2012). Evaluation of vegetable oils against pulse beetle, *Callosobruchus chinensis* (Coleoptera: Bruchidae) infesting pea seeds (*Pisium sativum* L.). Journal of Horticulture 18:46-53.

Bennet RN, Wallsgrove RM (1994). Secondary methods in plant defense mechanisms. New Phytology 127:617-633.

Cortesero AM, Stapel JO, Lewis WJ (2000). Understanding and manipulating plant attributes to enhance biological control. Biological Control 17:35-49.

Dugje IY, Omoigui LO, Ekeleme F, Kamara AY, Ajeigbe H (2009). Farmers' guide to cowpea production in West Africa. International Institute of Tropical Agriculture, Ibadan Nigeria 20:12-14.

Gatehouse JA (2008). Biotechnological prospects for engineering insect-resistant plants. Plant Physiology 146:881-887.

Ileke DK, Olotuah OF (2012). Bioactivity of *Anacardium occidentale* (L) and Allium *sativum* (L) powders and ils extracts against cowpea bruchid, *Callosobruchus maculatus* (Fab.) (Coleoptera:Chrysomelidae). International Journal of Biology 4:96-103.

Ileke KD, Odeyemi OO, Ashamo MO (2013). Varietal resistance of some cowpea cultivars to cowpea bruchid, *Callosobruchus maculatus* (Fab.) (Coleoptera: Chrysomelidae) infestation. Journal of Research in Sciences 1:72-81.

Kanaji GAD (2007). A study of bruchid resistance and its inheritance in Malawian dry bean germplasm. A Thesis submitted in fulfillment of the requirements of the degree of Doctor of philosophy (PhD) in plant breeding. Submitted to Kwazulu University, Natal Republic of South Africa. Available at: https://pdfs.semanticscholar.org/f97f/17ca0727843b4af82c933927dcc4f6b6fe6e.pdf

Lale N, Kolo AA (2006). Susceptibility of eight genetically improved local cultivars of cowpea to *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in Nigeria. International Journal of Pest Management 44:25-27.

Melkassa Agricultural Research Center (MARC) (1995). Experiences in lowland crops research. Proceedings of the 25th Anniversary of Nazareth Research Center, Nazareth, Ethiopia. Available at: http://publication.eiar.gov.et:8080/xmlui/handle/123456789/1025

Melkassa Agricultural Research Center (MARC) (1996). Melkassa Agricultural Research Center profile, Melkassa.

Mbata GN (1993). Evaluation of susceptibility of varieties of cowpea to *Callosobruchus maculatus* (F.) and *Callosobruchus subinnotatus* (Pic.) (Coleoptera: Bruchidae). Journal of Stored Product Research 2:207-213.

Ministry of Agriculture (MoA) (2000). Agro-Ecological Zonation's of Ethiopia. Addis Ababa. Available at: https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/ReferencesPapers.aspx?ReferenceID=2039760

Painter RH (1951). Insect resistance in crop plants. New York, NY: Macmillan Co. 520p. DOI 10: 00010694-195112000

Redden RJ, Dobie P, Gatehouse AMR (1983). The inheritance of seed resistance to *Callosobruchus maculatus* F. in cowpea (*Vigna unguiculata* L.). I. Analyses of parental, F1, F2, F3 and backcross seed generations. Journal of Crop Pasture Science 34:681-695.

Sharma S, Thakur DR (2014). Biochemical basis for bruchid resistance in cowpea, chickpea and soybean genotypes. American Journal of Food Technology 9:318-324.

Swella GB, Mushobozy MK (2007). Evaluation of efficacy of protectants against cowpea bruchids (*Callosobruchus maculatus* (F.) on cowpea seeds (*Vigna unguiculata* (L.). Plant Protection Science 43:68-72.

Taylor TA (1981). Distribution, ecology and importance of bruchids attacking grain legumes and pulses in Africa. In The ecology of bruchids attacking legumes (pulses). Springer, Netherlands. pp. 199-203.

Tsion T, Ranjan SK, Teklu T (2009). Farmers training programme of Ethiopian Institute of Agricultural Research: An appraisal. African Journal of Agricultural Resource 4:409-421.