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Physical Purity of Cowpea Seeds from Trained Community Based and Licensed Seed Producers in Three States of Nigeria

Iyorkaa Nater[1, 2, *], Omoigui Osabuohein Lucky[1, 2, 3], Odo Peter[1], Kamara Alpha Yaya[3], Ugbaa Macsamuel Sesugh[1, 2, 4], Ekeruo Godspower Chibuike[1, 2]

[1]Department of Plant Breeding and Seed Science, College of Agronomy, Federal University of Agriculture Makurdi, Makurdi, Nigeria
[2]Molecular Biology Laboratory, Federal University of Agriculture Makurdi, Makurdi, Nigeria
[3]International Institute of Tropical Agriculture (IITA), Kano Station, Kano, Nigeria
[4]Center for Innovation in Procurement, Environmental and Social Standards (CIPESS), Federal University of Agriculture Makurdi, Makurdi, Nigeria

Abstract

The study was conducted to compare two main sources of cowpea seed, Community Based Seed Producers (CBSP) and Licensed Seed Producers (LSP) for physical purity indices. From each seed source in every state, 15 seed samples of between 2 to 3 kg were collected for seed quality analysis. The collected seed samples were bulked according to variety, state, and seed source and then reduced to a working sample of four (4kg) using a modified halving method. The 4 kg was then divided into four equal parts as replicates. Seed purity was measured by sorting 1 kg of each working sample. The treatments were laid out in a completely Randomized Design (CRD) with four replications in the Molecular Biology Laboratory, Federal University of Agriculture, Makurdi. The experiment was set up as a factorial combination on pure seeds, using 2 (seed source) × 3 (States) × 3 (varieties). Data were collected on the following parameters; Percentage Pure Seed, Percentage Inert Matter, Percentage Off-types seeds, Percentage Field Insect Damaged Seeds, Percentage Rain Damaged Seed, Percentage Weevil Damaged Seeds and Percentage Seeds Moisture Content and was analyzed was carried out using Minitab, version 2017. Seeds from the different states were statistically comparable. However, for varieties, cowpea seeds were not comparable except for rain damage and inert matter. On seed source, community-based seed producers performed below the licensed seed producers with respect to seeds damaged by rain, field insect damage, inert matter, weevil damage, pure seeds and moisture content. They were however, comparable in terms of off-types and mater. The two seed sources however, met the minimum standard required for cowpea seed certification by the National Agricultural Seed Council (NASC) with respect to off types and inert matter and hence could be used as an alternative seed source without any serious disadvantage of seeds purity. Therefore, we concluded that farmers can obtain seed from community-based seed producers without any serious disadvantage in terms of purity of seed lot.

Keywords

Community Based Seed Producers, Licensed Seed Producers, Cowpea Seed Purity, Inert Matter, Off-type, Damaged Seeds, National Agricultural Seed Council

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* Corresponding author
E-mail address: nateriyorkaa@gmail.com (I. Nater)

1. Introduction

One of the most important factors for good crop production is the availability of good quality seeds of high yielding varieties, adapted to the growing area, and preferred by the farmers and consumers [1]. The quality of seeds alone is known to account for an increase in productivity of at least 10 - 15% [1]. Characteristics such as trueness to variety, germination percentage, physical purity and vigor are seed qualities which are important to crop farmers [2]. Farmers planting low quality seeds are at risk of poor field emergence, low plant vigor and low establishment count which translate to low yield [3]. Therefore, improving the availability of high quality seeds of well-adapted varieties is important to boost farmers' productivity, leading to higher farmer's income, and improved food security [4].

Cowpea (*Vigna unguiculata* L. Walp.) is one of the most important grain legume and a major staple food crop for household nutrition in sub-Sahara Africa, especially in the dry savanna regions of West Africa. It plays an important role in human nutrition, food security, and income generation for both farmers and people trading on it in the region according to African Agricultural Technology Foundation [5]. The grain is rich in protein (25%), carbohydrates, vitamins, and minerals. In addition, to the grain, the haulms (biomass) from the plants provide important nutritious fodder for ruminant animals especially during the dry season [1].

Non-availability of quality seed of improved cowpea varieties due to lack of a functional and efficient seed delivery systems in most west African countries [5]. To ensure availability of improved cowpea among farmers, International Institute of Tropical Agriculture (IITA) in collaboration with Federal University of Agriculture, Makudi (FUAM), and other agencies have implemented a community-based seed production scheme (CBSPS) where farmers were trained in relevant aspects of cowpea seed production and post-harvest handling. About 76% of cowpea seed used by farmers in 2015 comes from the community- based seed producers (CBSP), which represents the informal seed system compared to the license seed producer (LSP), the formal seed system, which accounts for only 24% [6]. Seed from the formal seed system follow and meet a well-defined certification requirements for seed development, production and commercialization process for variety/hybrid seed sold to farmers. On the other hand, seed from the informal seed system does not follow the rigorous certification requirement. The quality of this seeds is based on trust and perception the farmers have on the CBSP [3]. Consequently, there is a general perception that the quality of the seed coming from CBSP will be compromised. Hence, there is need to assess the seeds from the CBSP for physical qualities in relative to the one from the LSP.

2. Materials and Methods

States, Seed Source and Cowpea Varieties used for the Study

Cowpea seeds were sampled from seed companies and community based seed producers across the three states of Kano, Benue and Jigawa where varieties IT99K-573-1-1, IT99K-573-2-1 and UAM09 1051-1 were used for the study. The selection of locations was based on the popularity and availability of the target varieties among farmers. Seed sampling was targeted of the seed farmers who received their training from Tropical Legume Seed Systems [6] in each location.

Time of Seed Sample Collection and Number of Samples Collected

Cowpea seed samples were sourced between 1st to 14th June in 2016 and 2017 cropping seasons from fifteen (15) seed producing farmers from each state of Jigawa, Kano and Benue. Also fifteen (15) seed samples were collected from each seed companies in Jigawa, Kano and Benue.

Experimental Design and Treatments

Cowpea seed quality was evaluated in the screen house using a factorial combination on pure seeds with the following factors as treatments

2. Seed sources consisting of CBSP and LSP

3 States consisting of Benue, Jigawa and Kano

3 Varieties consisting of IT99K-573-1-1, IT99K-573-2-1 and UAM09 1051-1

The experimental design was Completely Randomized Design (CRD) with four replications in the laboratory.

Preparation of Seed Samples for Quality Analysis

The collected seed samples were bulked according to variety, state of origin and seed source and then reduced to a working sample of four (4kg) using modified halving method as recommended by International Seed Testing Association [7]. The 4 kg was then divided into four equal parts as replicates. Seed quality parameters were determined from the 1kg working seed samples as follows:

Seed purity (Genetic and Physical)

Seed Moisture Content

Evaluation of Cowpea Seed Samples for Seed Purity

Seed purity was measured by sorting 1 kg of each working sample. The experiment was conducted in the Molecular Biology Laboratory, Federal University of Agriculture, Makurdi during year 2016 and 2017. The seed samples were divided into six categories of: pure seeds, field insect damaged seeds, off-type seeds, weevil damaged seeds, rain damaged and inert matter as described by the International

Seed Testing Association (ISTA) standards for pure seed [7].

Determination of Seed Quality Parameters:

The seed quality of the samples were determined in accordance to ISTA classification of cowpea seeds as follows: broken seeds, very small seeds, other crops and weed seeds were considered as inert matter; Off-type seeds were the seeds that showed differences in seed shape and color; Weevil damaged seeds were all the seeds with weevil exit hole; Rain damaged seeds were all the seeds that changed color because of moisture from the rain; Field insect damaged seeds were all the seeds that were injured by maruca, and pod-sucking bugs in the field; Pure seeds were the balance of each working sample after inert matter, off types and damaged seeds were sorted out.

Seed purity parameters were weighed with a WANT-Balance Instrument model WT-CF, pan size 160mm and 0.01g accuracy and calculated using the following formulae:

1. Percentage pure seed

$$\% \text{ pure Seed} = \frac{\text{Wt of pure seed}}{\text{Total wt of sample}} \times 100$$

2. Percentage inert matter

$$\% \text{ Inert matter} = \frac{\text{Wt of Inert matter}}{\text{Total wt of sample}} \times 100$$

3. Percentage off type seed

$$\% \text{ off type} = \frac{\text{Wt of off type}}{\text{Total wt of sample}} \times 100$$

4. Percentage field insect damaged seed

$$\% \text{ damaged seeds} = \frac{\text{Wt of insect damaged seeds}}{\text{Total Wt of seeds used}} \times 100$$

5. Percentage Rain damaged seed

$$\% \text{ Rain damaged seeds} = \frac{\text{Wt of rain damaged seeds}}{\text{Total Wt of seeds used}} \times 100$$

6. Percentage Weevil damaged seed

$$\% \text{ Weevil damaged seeds} = \frac{\text{Wt of weevil damaged seeds}}{\text{Total Wt of seeds used}} \times 100$$

Evaluation of Cowpea Seed Samples for Moisture Content

Seed moisture content was measured on pure seed from the working samples using Digital Moisture Testing Meter model (Farmex MT-16) in the laboratory with four replications for moisture content

Data Analysis

The data collected from purity test and seed moisture content were subjected to analysis of variance (ANOVA). Treatment means were separated and ranked using Tukey Pairwise Comparisons (TPC). All data analysis was carried out using Minitab, version 2017.

3. Results

Seed Quality Parameters as Influenced by Variety, State and Seed Source

Main effects of variety, state and seed source on seed quality parameters is presented in Table 1. The main effects of variety showed that variety IT99K-573-2-1 significantly had higher percentage number of field insect damaged seeds compared to varieties IT99K-573-1-1 and UAM09 1051-1 with mean values of 2.77% 1.63% and 1.27%, respectively. A similar trend was also observed in percentage weevil damaged seeds where variety IT99K-573-2-1 had higher number of weevil damaged seeds than varieties UAM09 1051-1 and IT99K-573-1-1 with means of 3.03%, 1.33% and 1.09%, respectively. There was also a significant higher percentage number of off types seeds from variety IT99K-573-2-1 over varieties IT99K-573-1-1 and UAM09 1051-1 with means of 0.30%, 0.19% and 0.05%, respectively as presented in table 3. The result also showed significantly higher percentage seed moisture content from variety IT99K-573-2-1 over varieties IT99K-573-1-1 and UAM09 1051-1 with means of 13.15%, 13.02% and 12.86%, respectively. The result showing the main effects of variety on seed quality of cowpea showed that variety IT99K-573-2-1 significantly had the least percentage number of pure seeds compared to varieties IT99K-573-1-1 and UAM09 1051-1 with values of 90.36%, 93.43% and 93.50%, respectively.

Table 1. Means of variety, state and seed source on selected seed quality traits of cowpea.

	% RD	% FID	% WD	% OT	% IM	% PS	% MC
Variety Means							
IT99K-573-1-1	2.73a	1.63b	1.09b	0.05b	1.30a	93.43a	13.02ab
UAM09 1051-1	2.31a	1.27b	1.33b	0.19ab	1.49a	93.50a	12.86b
IT99K-573-2-1	1.81a	2.77a	3.03a	0.30a	1.81a	90.36b	13.15a
State Means							
Bnue	2.75a	2.00a	1.74a	0.17a	1.47a	91.87a	13.09a
Jigawa	2.40a	2.06a	2.38a	0.21a	1.35a	92.00a	12.95a
Kano	1.70a	1.62a	1.33a	0.16a	1.78a	93.41a	12.98a
Seed Source Means							
CBSP	4.33a	2.29a	2.36a	0.19a	2.20a	88.90b	13.91a
LSP	0.24b	1.49b	1.28a	0.17a	0.87b	95.95a	12.10b

Means with same letters in a Colum are not significantly different, CBSP = Community Based Seed Producer, LSP = Licensed Seed Producer, RD = Rain Damaged, FID = Field Insects Damaged, WD = Weevil Damaged, OT = Offtype, IM = Inert Matter and PS = Pure Seeds, MC = Moisture content, National Agricultural Seed Council minimum standards for cowpea seed certification for Off-types = 0.2%, Inert matter = 2.0%, Pure seeds = 98% and Moisture content = 10-12%.

There was no significant difference for variety with respect to percentage rain damaged seeds and inert matter as shown in table 3. Variety IT99K-573-2-1 performed below the NASC minimum standard of 0.2% for cowpea seed certification with respect to percentage off type. In the same vein all the cowpea varieties tested failed to meet the NASC minimum standard for certification with respect to percentage pure seeds and moisture content of 98% and 10-12% respectively. The result comparing cowpea varieties showed that all the varieties tested met the NASC requirement for certification with respect to percentage inert matter of 2.0% as well as varieties IT99K-573-1-1 and UAM09 1051-1 for percentage off types as presented in table 1.

The main effects of location on seed quality parameters presented in Table 1 showed that there was no significant difference among the three states where cowpea seeds were sampled with respect to all seed purity parameters tested. According to the result presented in table 1, all the locations met the NASC minimum standard of 0.2% and 2.0% for cowpea seed certification with respect to percentage off types and inert matter. The result again showed that all the locations failed to meet the NASC minimum standard of 98% and 10-12% respectively for certification with respect to percentage pure seeds and moisture content.

Results of the main effects of seed source on seed quality parameters presented in table 1 showed that CBSP significantly had higher percentage number of rain damaged seeds compared to the LSP with mean values of 4.33% and 0.24%, respectively. A similar trend was also observed in percentage filed insect damaged seeds where community based seed producers had 2.29% higher than the licensed seed producers with mean value of 1.49%. In a similar vein CBSP also had significantly higher percentage number of inert matter compared to the LSP with mean values of 2.20% and 0.87%, respectively. There was also significantly higher percentage seed moisture content from community based seed samples compared to the licensed seed samples with mean values of 13.91% and 12.10%, respectively. The result comparing CBSP and LSP with respect to seed quality of cowpea presented in table 1 showed that community based seed producers had the less percentage number of pure seeds compared to the licensed seed producers with mean values of 88.90% and 95.95%, respectively. The result again revealed that the two seed sources (community based and licensed seed producers) were similar with respect to percentage weevil damaged seeds, percentage off types. According to the result presented in table 1, community based and licensed seed producers met the NASC minimum quality standard of 0.2% for cowpea seed certification with respect to percentage off types. The result on the other hand showed that the two seed sources failed to meet the NASC requirement of 98% and 10-12% for cowpea seed certification with respect to percentage pure seeds and moisture content. For percentage inert matter, only the licensed seed producers met the NASC minimum standard of 2.0% for cowpea seed certification as presented in table 1.

Seed Quality Parameters as Influenced by Variety × State Interaction

The effects of variety x state interaction on percentage rain damage and percentage field insect damage is presented in table 2. The result showed that variety x state source significantly influenced percentage rain damage seeds. Variety UAM09 1051-1 had higher percentage rain damage from Benue state followed by variety IT99K-573-2-1 from Jigawa state and Kano state with mean values of 13.20%, 13.17% and 13.15% for Benue, Jigawa and Kano, respectively. The least percentage rain damage seeds were obtained from variety UAM09 1051-1 in Jigawa state with mean value 12.64%. The variety, IT99K-573-1-1 was not significantly different across the three states ranging from Benue, Jigawa and Kano states with mean values of 12.97%, 13.03% and 13.05%, respectively. The result for variety × state interaction on percentage field insect damage showed that variety UAM09 1051-1 in Kano and Jigawa states and variety IT99K-573-1-1 in Jigawa state had the least percentage field insect damage seeds with mean values of 0.86%, 1.03% and 1.06%, respectively. Variety IT99K-573-2-1 had significantly higher percentage field insect damage seeds in Jigawa state with mean values 4.09%. Benue state showed average higher percentage field insect damage for variety IT99K-573-1-1 and variety UAM09 1051-1 with mean values of 2.01% and 1.92%, respectively above variety 573-1-1 in Jigawa location. A similar level was observed on variety IT99K-573-1-1 in Kano state and variety IT99K-573-2-1 in Benue and Kano states with mean values of 1.83%, 2.06% and 2.16%, respectively.

Seed Quality Parameters as Influenced by Variety × Seed Source Interaction

The result of variety x seed source interaction is presented in table 3 below. The result shows that the highest percentage of off-type seeds were obtained from variety IT99K-573-1-1 and UAM09 1051-1 from licensed seed producers and variety IT99K-573-2-1 from community based seed producers with mean values of 0.30%, 0.31 and 0.40%, respectively. Variety UAM09 1051-1 and IT99K-573-1-1 had the least percentage off-types from community based seed producer compared to licensed seed producers with mean values of 0.08% and 0.08%, respectively. On a contrary variety IT99K-573-2-1 gave a lesser percentage of off-types

from the licensed seed producers with mean value of 0.19%, respectively.

Table 2. Means of Variety x State Interactions on Selected Quality Traits of Cowpea.

Variety	% Rain Damage	% Field Insect Damage				
	Benue	Benue	Jigawa	Kano	Jigawa	Kano
IT99K-573-1-1	12.97ab	2.01ab	1.06b	1.83ab	13.03ab	13.05ab
UAM09 1051-1	13.20a	1.92ab	1.03b	0.86b	12.64b	12.74ab
IT99K-573-2-1	13.11ab	2.06ab	4.09a	2.16ab	13.17a	13.15a

Means with same letters within a parameter are not significantly different

Table 3. Means of Variety x Seed Source Interactions on Selected Seed Quality Traits of Cowpea.

Variety	% Off types		% Inert Matter		% Pure Seeds		% Moisture Content	
	CBSP	LSP	CBSP	LSP	CBSP	LSP	CBSP	LSP
IT99K-573-1-1	0.08b	0.30a	2.18ab	0.42c	88.22c	98.63a	14.08a	11.95c
UAM09 1051-1	0.08b	0.31a	9.46abc	1.51abc	90.40c	96.59ab	13.71a	12.01bc
IT99K-573-2-1	0.40a	0.19ab	2.94a	0.68bc	88.09c	92.63bc	13.95a	12.34b

Means with same letters within a parameter are not significantly different, CBSP: Community Based Seed Producer and LSP: Licensed Seed Producer and National Agricultural Seed Council minimum standards for cowpea seed certification for Off-types = 0.2%, Inert matter = 2.0%, Pure seeds = 98% and Moisture content = 10-12%.

The result showed that, variety IT99K-573- 1- 1 had the highest seed moisture content at Kano state from CBSP with mean value of 14.13% followed by Jigawa state with mean value of 14.11%. The least moisture content was observed from LSP with mean values of 11.98%, 11.94% and 11.94%, respectively for Kano, Jigawa and Benue states for variety IT99K-573-1-1. In variety UAM 09 1051-1, the seed moisture content was significantly higher from community based seed producers in Benue state with mean value 14.39%, followed by Kano and Jigawa states with mean values of 13.43% and 13.31%, respectively. The lowest seed moisture content was observed from licensed seed producers in Jigawa state with mean value 11.98% followed by Benue and Kano states with mean value 12.01% and 12.04%, respectively for variety UAM 1051-1.

Across the board, variety UAM 09 1051-1 was observed to be significantly higher with respect to seed moisture content from community based seed producers coming from Benue state with mean value 14.39%. Meanwhile, variety IT99K-573-1-1 significantly gave the least seed moisture content from licensed seed producers from Benue and Jigawa states with mean values 11.94% and 11.94%, respectively. Community based seed producers had moisture content above the 10 - 12% NASC minimum standard for cowpea seed certification across the three states. Only 5% out of the licensed seed producers had moisture content above NASC standard. Majority of the licensed seed producers across the three states in all the varieties has moisture content within the range of NASC standard for certification.

The result of the interaction between variety and seed source revered that variety IT99K-573-1-1 had the least percentage inert matter from the licensed seed producers compared to community based seed producers with mean difference of 0.42% and 2.18%, respectively. A similar trend was also observed on variety UAM 09 1051-1 with mean values of 1.51% and 9.46% from licensed seed producers and community based seed producers, respectively. For variety IT99KK-573-2-1 also, the licensed seed producers had the least percentage inert matter compared to the community based seed producers with mean values of 0.68% and 2.94%, respectively. In general, the licensed seed producers significantly had lower percentage inert matter than the community based seed producers.

Variety x seed source interaction significantly affected percentage pure seeds. Variety IT99K-573-1-1 had higher percentage pure seed from the licensed seed source compared to the community based seed source with mean values of 98.63% and 88.22%, respectively. Variety UAM09 1051-1 also showed a similar trend of 96.59% and 90.40% from licensed and community based seed sources, respectively. Variety IT99K-573-2-1 also showed significantly higher percentage pure seeds from the licensed seed source with mean value of 92.63% compared to the community based seed source that had 88.09% pure seeds. Community based seed source did not show any significant difference among the cowpea varieties tested. The licensed seed producers significantly gave higher percentage pure seeds compared to community based seed producers. The highest percentage pure seeds were obtained from variety IT99K-573-1-1 which emanated from the licensed seed producers with mean value of 98.63%, while the least percentage pure seed was obtained from variety IT99K-573-2-1 from CBSP with mean value of 88.09% as presented in the table 3.

The result of variety x seed source interaction on seed moisture content presented in table 3 showed that variety IT99K-573-1-1 significantly had the least and the highest percentage seed moisture content (11.95%) from the licensed and community based seed producers (14.08%), respectively.

The cowpea varieties tested showed no significant difference with respect to percentage seed moisture content from the community based seed producers. Varieties IT99K-573-2-1 and UAM1051-1 had average seed moisture content from the licensed seed producers below the community based seed producers with mean values of 12.34% and 12.01%, respectively. In general, the licensed seed producers performs better in respect to percentage seed moisture content compared to the community based seed producers.

All the samples tested meet the NASC 0.2% minimum standard for certification except form varieties UAM1051-1 and IT99K-573-1-1 in the licensed seed producers and variety IT99k-573-2-1 in the community based seed producers with means 0.30%, 0.31% and 0.40%, respectively. Community based seed producers failed to meet up with the NASC 2.0% minimum standard for certification with respect to percentage number of inert matter. Community based seed producers did not meet up with the NASC minimum standard of 98% pure seed for certification. One variety IT99K-573-1-1 met the NASC minimum standard for certification with mean percentage pure seeds of 92.63% from the licensed seed producers. Community based and licensed seed producers failed the NASC minimum standard for cowpea seed certification with respect to seed moisture content in all the varieties tested except in variety IT99K-573-1-1 from the licensed seed producers as presented in table 4.

Means of Variety x State x Seed Source Interaction on Seed Moisture Content of Cowpea

The effects of variety × state × seed source interaction on percentage seed moisture content is presented in table 4. The result showed that, variety IT99K-573- 1- 1 had the highest seed moisture content at Kano state from community based seed sample with mean value of 14.13% followed by Jigawa state with mean value of 14.11%.

Table 4. Means of Variety x State x Seed Source Interactions on Seed Moisture Content of Cowpea.

	Benue		**Jigawa**		**Kano**	
	CBSP	**LSP**	**CBSP**	**LSP**	**CBSP**	**LSP**
IT99K-573-1-1	14.00abc	11.94d	14.11ab	11.94d	14.13ab	11.98d
UAM09 1051-1	14.39a	12.01d	13.31c	11.98d	13.43bc	12.04d
IT99K-573-2-1	13.81abc	12.42d	14.11ab	12.23d	13.94abc	12.37d

Means with same letters are not significantly different, CBSP: Community Based Seed Producer and LSP: Licensed Seed Producer and National Agricultural Seed Council minimum standards for cowpea seed certification for Moisture content = 10-12%.

The least moisture content was observed from licensed seed source with mean value ranging from 11.98%, 11.94% and 11.94% in Kano, Jigawa and Benue states, respectively under variety IT99K-573-1-1. In variety UAM 09 1051-1, the seed moisture content was significantly higher from community based seed producers in Benue state with mean value 14.39%, followed by Kano and Jigawa states with mean values 13.43% and 13.31%, respectively. The lowest seed moisture content was observed from licensed seed producers in Jigawa state with mean value 11.98% followed by Benue and Kano states with mean value 12.01% and 12.04%, respectively for variety UAM 1051-1. Across the board, variety UAM 09 1051-1 was observed to be significantly higher with respect to seed moisture content from community based seed producers coming from Benue state with mean value 14.39%. Meanwhile, variety IT99K- 573-1-1 significantly gave the least seed moisture content from licensed seed producers from Benue and Jigawa states with mean values 11.94% and 11.94%, respectively. Community based seed producers had moisture content above the 10-12% NASC minimum standard for cowpea seed certification across the three states. Only 5% out of the licensed seed producers had moisture content above NASC standard. Majority of the licensed seed producers across the three states in all the varieties has moisture content within the range of NASC standard for certification.

4. Discussion

The level of susceptibility of the different varieties to weevils or field insects such as Maruca and Pod sucking bugs could be due to the post-harvest handling and seed storage materials or conditions by the seed producers. Matiki *et al.* [8] reported that, factors such as poor storage could result to attacks by bruchids and fungi causing seeds not to germinate. Biemond *et al.* [9] also reported a high level of damaged cowpea seeds by weevils as a major storage pest amongst farmers who use traditional methods of storage. According to Oluwafemi [10], attacks by bruchids result to qualitative and quantitative losses evidenced by seed perforations hence reduction in weighs, loss of market value and germination of seeds. According to Egho [11], pods sucking bugs attacked on young and adult pods of cowpea can cause seed contamination by transmitting disease pathogens to the seed that may cause seedling mortality on the field. The seed damage injury by weevils which was not significantly different indicated the effectiveness of the training the community based seed producers received from the TLIII seed. It could also be due to the seed packaging materials used by farmers among the three states as most of the seed

producers across the states used PICS sacks to store their cowpea seeds. The result agreed with the findings by Mary [12], who also observed no significant difference in state with respect to damaged seeds. Biemond *et al.* [13] also reported a similar result when they compared seed qualities of cowpea from different seed sources in Kaduna and Borno state of Nigeria. This agreed with Bishaw *et al*. [14] who observed no significant difference in physical and physiological quality of wheat seed samples obtained from different sources.

The result showed no significant difference on percentage number of off types among the states. This could be due to effectiveness of the training of seed producers in those locations received from the tropical legume seed systems project. In other words, the community based seed producers were effective in facilitating speedy cowpea seed production campaign among the states. This was evidenced in application of recommended cultural practices such as rouging, weeding in their farms among others. The result disagreed with the findings by Biemond *et al.,* [13] who reported differences in samples collected from different farmers in Borno and Kaduna states on cowpea with respect to percentage off-types. The mean percentage inert matter which was not significant different across the states could be attributed to adequate weeding applied by the licensed seed producers who weeded their field twice and the community based seed producers who carried out basic field sanitation such as weeding and rouging of off-types plants in the field. Bishaw *et al.* [14] compared the physical quality of wheat seeds samples collected from different regions in Ethiopia and reported a slight difference in the regions studied. The findings could be due to the fact that most of the seeds producers in those states rogued the off-types plants before maturity. Ensermu *et al.* [15] also reported low and no significant difference at 0.05% analytical purity analysis on farm Saved seeds from different regions in Ethiopia on wheat.

From the result, community based seed producers significantly had higher percentage number of rain damaged seeds compared to the licensed seed producers. In a similar way, community based seed producers significantly had higher percentage number of field insect damage seeds compared to the licensed seed producers. The result could be possible due to the inability of the community based seed producer to control maruca and pods sucking bugs on their fields or due to their inability to access seed cleaning facilities. Similarly, no significant difference was reported for analytical purity and other crop seed contamination for seed samples collected from different sources in barley [16] and in wheat [15] in Ethiopia. A similar observation was made in an experiment carried out on okra [17]. They observed that okra seeds obtained from seed companies were more pure than the seeds obtained from farmers. Ochran [18], also reported a similar observation on cowpea where seeds collected from formal sources were more pure as compared to seeds from the informal sources. Michael *et al.* [19] admitted that it is not possible to remove all foreign materials as well as bad seeds due to the high cost of sorting and selection. However, Bishaw *et al.* [14] reported that farmers use local selection, treatment, cleaning and storage methods to maintain the quality status of their seeds which make it impossible for them to have a completely pure seeds. From the result, community based seed producers significantly had higher percentage number of weevil damaged seeds compared to the licensed seed producers due to the inability to access seed cleaning equipment/machine by community based seed producers. The result disagreed with the findings by Biemond *et al.* [13] who reported that weevil damaged seeds were not significantly different when farmers seeds were compared with licensed seed producers in Borno and Kaduna States.

The percentage rain damage as affected by variety x state interaction showed highly significant difference except for variety IT99K-573-1-1 that showed no significant difference in the three states. From the result however, there was some degree of inconsistency in ranking the seed lots relative to variety and state. The result disagree with the findings by Bortey *et al.* [20] who reported no significant difference in the analytical purity of wheat seeds from different locations in Ethiopia. The result could be due to the amount of rain moisture at the time of harvest as the early maturing variety was more affected by rain damage than the late maturing variety UAM09 1051-1. The mean percentage of field insect damaged seeds showed that there was significant difference among the states with respect to varieties of cowpea tested. The observed result could be due to the type of chemical used and competence of persons controlling insect pest on the field during cowpea production process. It could also be due to differences in the amount of humidity across locations in the different farmers fields among the states as some insect pest thrives well in humid environments. Biemond *et al.* [12] observed differences in cowpea varieties from different locations with respect to Maruca and Pod sucking bugs in Borno and Kaduna states, Nigeria. Egho [11], stated that, pod sucking bugs attached them salves on young and adult pods of cowpea and caused seed contamination by transmitting disease pathogens to the seed.

The lower percentage of off types from the community based and licensed seed producers within the recommended from some varieties could be attributed to proper rouging among seed producers. While the higher percentage of off-types observed from CBSP and LSP above recommended could be

due to non-adherence to seed production practices as well failure to rogue out other varieties and less optimum harvest practices. Additionally, seed processing heavily affects the plant quality [21]. The result also disagreed with Hasan *et al.* [22] who found out that, wheat seeds from farm saved had relatively high levels of other crops seeds and contamination. However, Michael *et al.* [20] reported that is not possible to completely remove all foreign seeds due to the high cost of sorting and selection.

The higher percentage of inert matter observed from the community based seed producers could be due to the local selection and seed cleaning methods used by farmers. The result agreed with the findings by Bishaw *et al.* [14] who reported that farmers do use local seeds selection, treatment, cleaning and storage to maintain the quality status of their farm saved seeds. Greven *et al.* [23] observed that the reduced percentage of seed purity below the recommended rate could also be attributed to poor seed production practices such as failure to rogue out other varieties, harvesting practices, threshing techniques and storage conditions. The result agreed with Fujisaka *et al.* [24] who reported fewer weed seeds in company's seeds compared to seeds obtained from farmers in a descriptive study of farming practices for dry seeded rain fed lowland rice in India. The variety x seed source interaction showed no significant difference in the community based seed producers. However, highly significant difference was observed in varieties from the licensed seed producers. The result also showed a reduced percentage number of pure seeds from the community based seed producers. The result agreed with the findings by Mary [12], who reported that the mean percentage pure seeds from farm saved seeds was below the recommended quality as it did not meet the minimum pure seeds composition of 98% as recommended by NASC and ISTA. A similar observation was reported by Rahman and Colleaques [17] in an experiment carried out on Okra where okra seeds obtained from seed companies were observed to have more pure seeds followed by those from government organizations with the least from farmers. Bishaw *et al.* [14] reported a similar result on soybean in Nairobi in an experiment comparing seed qualities from different sources. The higher percentage moisture content observed from the community based seed producers could be due to the post-harvest handling of the seeds by the different seed producers, for example community based seed producers do not have a conducive environment to dry their cowpea before threshing due to fear of attacks by some domestic pest like Goats and other animals and also fear of mixture by human being especially when they produce more than a variety. This could also be due to the fact that community based seed producers lack seed moisture testing equipment unlike the licensed seed producers that had seed moisture testing instrument. The result agreed with the findings by Bishaw *et al.* [14] who reported that farmers use local seeds selection, treatment, cleaning and storage to maintain the quality status of their farm saved seeds. Schaffer and Vanderlip [25] found that soybean seed germination was reduced in seeds processed with moisture contents less than 10%. Moisture content determines the rate at which seeds deteriorate and has profound impact on storage longevity of seeds. Seed drying to appropriate moisture content is known to increase the longevity of seeds [26] hence reducing seed moisture to the range of 10 to 12% essentially ensures retention of high germination for a year or more at ambient temperatures.

The significantly lower seed moisture content from the licensed producers than the community based seed in all the varieties across the three states could be due to the post-harvest handling of the seeds by the different seed producers, as community based seed producers had no conducive environment to dry their cowpea before threshing due to fear of attacks by some domestic pest like Goats and other animals and also fear of mixture by human being especially when they produce more than a variety. This could also be due to the fact that community based seed producers lack seed moisture testing equipment unlike the licensed seed producers that had seed moisture testing apparatus. The location differences could be due to the relative humidity in the store and the storage structures used by licensed seed and community based seed producers in the different states. The varietal differences could result from weather situation at the time of harvest. In most cases the early maturing cowpea variety were harvested during the time of rainfall and high humidity. This weather situation predisposed the cowpea harvest to all sort of pest and microbes attacked and deterioration. The result agreed with the findings by Jactzold *et al*, [27] that different agro-ecological zones experience different rainfall amount temperature and humidity. Schaffer and Vanderlip [25], found that soybean seed germination was reduced in seeds processed with moisture contents less than 10%. Moisture content determines the rate at which seeds deteriorate and has profound impact on storage longevity of seeds.

5. Conclusion

For most of the seed quality parameters, location had no adverse effect on seed quality. Seed qualities obtained from the three states met the NASC minimum standard for certification with respect to off types and inert matter. However, the three states failed to meet the NASC minimum standard with respect to pure seeds and moisture content. Cowpea varieties tested were not comparable for seed quality parameters except for rain damage and inert matter that were

compared. Cowpea varieties met the NASC minimum standard for certification with respect to off types and inert matter. However, varieties failed NASC minimum standard with respect to pure seeds and moisture content as well as variety IT99K-573-2-1 for percentage off types. Community based seed producers performed below the licensed seed producers with respect to rain damage, field insect damage, inert matter, weevil damage, pure seeds, moisture content and hence cannot be compared. However, they were comparable in terms of off types. Both the seed sources failed to meet NASC minimum standard for cowpea seed certification for most of the seed quality indices except for percentage inert matter where only community based seed producers failed to attain the NASC standard. However, both seed sources attained NASC minimum standard for certification with respect to off types. Variety x state interaction had affected percentage field insects damaged seeds and moisture content only. However, variety x seed source interaction affected percentage off types, inert matter, pure seeds and moisture content. Variety x state x seed source interaction had effects on percentage seed moisture content, but it did not affect other seed quality parameters.

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