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# A Brief Study on Agro Morphological Trait Characterization of Chickpea Variety's Germplasm to Improve Genetic Resources in Fadis, Ethiopia

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**Abstract**

According to the study, thirty-two chickpea accessions with eight check varieties have been characterized considering to its morphological characteristics. All accessions have exhibited absence of plant pigmentation, and the majority of them exhibited an erect plant growth type. Most accessions had an angular ram's seed shape and medium-length pods. Majority of accessions have exhibited early days of flowering and medium-sized seeds, while Plant height had the lowest coefficient of variation (0.04), and Days to 50% flowering had the highest coefficient of variation (0.57%). All accessions have been characterizing lately flowering whereas twenty-five accessions were lately matured than check varieties. Twenty accessions have produced more primary branches and twenty-four accessions produced higher pods per plant than the check varieties. Three clusters were present in the study. Days to 75% maturity and plant height have very significant positive association (r=+1.00) but there was no association between secondary branch and 100 seed weight.

**Keywords:** Characterization; Morphological trait; Accessions; Clusters

## Introduction

Ethiopian chickpea production is expected to continue growing and the number of smallholder farmers growing chickpea in Ethiopia has increased from 154,281 Ha in 2003 to 239,512 Ha in 2012 and the production has increased from 210,000 MT in 2006 to over 409,733 MT in 2012. Chickpea crop is the third most important grown legume crop and production Following common beans and Faba beans in Ethiopia as providing important source of farmer income and nutrition to poor farmers and the third most important pulse crop in the world [1].

In Ethiopia with the introduction of improved varieties and crop management techniques, chickpea has become progressively popular. The crop is now cultivated nearly 0.7 million households on an estimated 242,703 hectares (ha) of land, and in 2018 total production reached 499,426 tons, with average productivity of 2.058 tons per ha-1in 2018. The chickpea crop is the third most important export crop among legumes, generating US$61 million annually in the countries [2].

The crop's production and land area continue to fall short of their potential despite this development. According to estimates, there are two million ha of extremely appropriate land that might be used to grow chickpeas, with yields of up to five tons per ha-1. The Bale Highlands, a location in southeast Ethiopia, is one place that might gain. Farmers in this region, who rely heavily on the monoculture of wheat, are used to mechanical production and frequently overlook chickpea because it involves manual planting and harvesting, which is labor-intensive and expensive.

Chickpea is a versatile and the cheapest crop with multiple benefits for integrated crop-livestock farming systems. It is a crucial source of micronutrients and protein, enhances soil fertility by fixing nitrogen, has a small carbon footprint, helps to mitigate climate change, and is simple to add into crop rotations. It also has significant contribution to household incomes and international markets reserves of foreign currency. India, Pakistan, Mexico, Turkey, Ethiopia, and Myanmar are the top chickpea producing nations throughout the worldwide. The crop most likely came from the region that is now southeastern Turkey and the nearby Syrian regions [3]. The suggestion has been made that Ethiopia and India are secondary centers for the variety of cultivated chickpea.

The genetic diversity found in plant genetic resources ensures that genetic development will continue, as well as acting as insurance against unanticipated dangers to agricultural productivity. For the purpose of creating high yielding varieties and preserving their productivity in plant breeding procedures, genetic diversity studies of plants are crucial. Screening and selection for crop improvement varieties would be based on the presence of enhanced genotypes, which only depends on the presence of better agronomic traits along with disease resistance, earliness, and high yield. Unluckily, despite its nutritional benefits and economic significance, chickpea output is quite low per hectare because improved varieties and technologies developed by the research system in Ethiopia are not being used. This is mostly caused by the poor genetic makeup of the cultivars that are readily available [4].

Any breeding program needs genetic diversity because it gives plant breeders the chance to choose genotypes with high yields. Based on morphological features, which are traditional ways to separate variants based on the observation of external morphological differences in various geographic regions, one-way techniques of estimating genetic diversity is based on these differences. Additionally, morphological features are easy to score and inexpensive to use. The landraces displayed significant intra-and inter population heterogeneity in the research of Ethiopian chickpea morphological features [5]. The basis for choosing enhanced crop varieties is provided by its crucial information on the relationships between yield and other important components. Therefore, Characterization plays a crucial role in the

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identification of accessions or varieties because to the distinctive agro morphological qualities those are crucial for seed production, seed quality, seed certification, and genetic purity. Modern plant breeding and agricultural systems have narrowed the base for the genetic diversity of cultivated chickpea. This study's goal is to evaluate the morphological diversity of the selected chickpea accession varieties by analyzing qualitative and quantitative traits [6].

## Materials and Methods

### Experimental materials and study site

The experiment was conducted at Agdora demonstration and protected area which is located in Fadis Eastern Hararghe Zone in Oromia regional state of Ethiopia. Fadis is one of the districts in Eastern Hararghe, 658 km far from Addis Ababa and located 25 km, to the direction of East form Harar city and Agdora kebele is found in Fadis Woreda of Easter Hararghe zone far away 33km from Harar city and 8km from Fadis Woreda. Geographically, the study site is located at geographic position at latitude of 08o 02'30"-09o 00'14"N and longitude of 42o 06'02"-42o 19'00"E. The altitude in the sanctuary ranges from 1200 to 2118 m.a.s.l. Fedis is bordered on the southwest by Gola Odana Meyumuluke, on the west by Girawa, on the northwest by Haramaya, on the north by the Harari Region, on the east by Babile, and on the southeast by the Erer River which separates it from the Somali Region. There were 23 Farmers Associations with 29,713 members and 4 Farmers Service Cooperatives with 346 members (Wikipedia website accessed may 2018). Fedis has only dry-weather roads. The mean annual temperature is about 20.2°C, ranging from a mean minimum of 12.8°C to mean Maximum of 29.4°C [7]. There is only a slight difference in temperature throughout the year, with the hottest months during April to June (maximum 28.6°C) and the coldest during October to December (minimum 10.2°C). The mean annual rainfall is 740.6 mm per year, with high variation from year to year, ranging from 470.6 mm to 1270.4 mm per year. Rainfall is bimodal, occurring from February to April (short rain season) and June to September (long rain season) (Source: National Meteorological Service Agency of Ethiopia Data from 1965 to 2005) [8].

Thirty-two selected chickpea accessions with eight check verities were sown on the growing rainy season on 5th August 2021/22. All the agronomic practices and data collection were carried out throughout the crop growing and harvesting season. The experiment conducted on Characterization of qualitative and quantitative traits according to descriptor traits of Chickpea presented. For data on plant bases, the mean of five plants which were randomly selected from the two central rows for the plot bases and the two interior rows were used for data collection.

### Experimental design and layout

With three replications, a randomized block design (RBD) was adopted. Each accession was planted in five rows with a 3 m2 (1 m x 3 m) plot area, with blocks and plots spaced apart by 1.5 m and 0.65 m, respectively. Using a 0.15m gap between plants, 100 seeds were planted in each plot. Randomly chosen five plants per plot from each accession were tagged and used to capture data on morphological traits. The morphological data recorded on qualitative and quantitative agronomic traits were collected during the cropping season according to descriptors of chickpea. The data recording on qualitative and quantitative characters were listed with its measuring scale and period of time presented. The data collection on qualitative and quantitative characteristics were listed respectively, along with the measuring scale and time period used [9].

### Statistical data analysis

Using SAS statistical software, the analysis of variance (ANOVA) was done to determine the variation in agro-morphological traits. Using straightforward statistical metrics like mean, range, genotypic and phenotypic variances, and coefficient of variations, the variation of each morphological attribute, such as quantitative traits, was assessed. The phenotypic and genotypic variation and coefficient of variations were calculated following the formula suggested [10].

## Results and Discussion

### Qualitative traits

Qualitative traits characterization of thirty-two accessions and two chick varieties were characterized based on the characteristics described in the Distinctiveness, Uniformity and Stability guidelines. Characterization through morphological traits has been used as a major component for identification of genotypes or cultivar varieties. Identification of any cultivar is not possible based on a single trait where a detailed morphological description of plants and seeds should be characterizing. 12 qualitative traits of accessions were characterized presented. All accessions were characterized as absences of plant pigmentation, no variations have occurred on plant pigmentation. This result is similarly to the report conducted. Most accessions were characterized by erect plant growth type followed by semi erect plant growth type. Accessions were dominantly characterized as pink flowering color followed by light pink flowering color [11]. Flower color is one of the most important and easily observable qualitative traits and widely used as a marker gene in genetic studies and breeding work line up with the reports conducted. As the result showed that most accessions were characterized by medium pod length 23(72%) followed by short pod length 7(22%). Chickpea pod size variations were observed due to polygenic control and, genotypic, environmental and genotypic with environmental interactions factors agreed with report conducted.

On the basis of seed shape all thirty-two accessions were categorized into three types of seed shape presented. As the result most of accessions were characterized angular ram's head shape25 (78%) followed by irregular rounded owl's head shape6 (19%). And majority of accessions were characterized rough seed texture 21(66%) followed by tuberculated texture 6(19%). This result is agreed with report conducted. Based on Seed color variations observed all accessions were characterized as 22(69%) accessions yellow to orange yellow, 4 (13%) accession brown to reddish brown, 2 (6%) accessions light orange to light, 2 (6%) accessions black brown mosaic and 2 (6%) accessions were green to light green seed color. Most accessions were characterized as yellow to orange yellow seed color. Characterization of various agro-morphological traits such as seed size, seed testa texture, seed shape and seed color facilitate for selection of desirable traits and genetic varieties. This result is line up with research conducted by. All accessions were characterized as short heighted (< 45 cm) [12,13]. based on 100 seed weight accessions seed size most seed size of accessions was characterized medium seed size 22(68.75%) followed by small seed size 10(31%). All accessions were characterized as absences of seed shattering and lodging. Based on days to 50% flowering of accessions were characterized as 24(75%) early flowering date, 8(25%) medium flowering date but no late flowering dates were observed on the studied accessions. Agro-morphological characterizations of accession have been a major component of varietal identification and efficient

utilization in the breeding program. It is not possible to identify advanced varieties using any single parameter. Therefore, a detailed morphological description of plants and seeds should be characterized and assigned distinctive morphological profiles characterization.

Differential traits in respect of growth type, plant height, days to 50% flowering, seed size, seed color, flowering color, seed shape, primary branch, secondary branch, pods per plant,100 seed weight in gram, yield per plot and yield in kilogram per hectare showed significant variation in yield which leads to distinguish from each other. Similar results noticed by. Utilization of agro-morphological features in sequential fashion is useful and convenient to distinguish different genotypes. Similarly, genotypes identification based on distinguishable morphological characters were reported in chickpea [14-16].

Nine quantitative traits of accessions along with two check varieties were characterized. The highest coefficients of variation (CV) were observed for Days to 50% flowering (0.57%), Secondary branch (0.49%), 100 Seed weight (0.47%) and Yield per hectare (0.34%). While Primary branch (0.06%), Days to 75% maturity (0.06%) and Plant height (0.04) were observed least coefficient of variation.

The days to 50% flowering were recorded from 51 to 66th days after sowing and days to 75% maturity were recorded from 79th to 92th days. All accessions were flowering later than the check varieties, whereas 7 accessions matured earlier and 25 accessions were later matured check varieties. 22 accessions were produced more primary branches than the check varieties and all accessions were produced more secondary branches than check varieties. 24 accessions produced higher pods per plant compared to the check varieties and the highest 142 pods per plant was recorded for EBI-30345 with better yield per plot (524) and yield per hectare (1748) compared to all check varieties. When increasing the plot size and block replication number at the same location and environmental conditions as well as number of check varieties, no significant morphological variation of accessions was occurred. This result is agreed with the report conducted [17,18] (Table 1).

## Genetic diversity analysis

**Cluster analysis:** Three clusters were grouped presented in Tables 2 and 3 Cluster I consisted of 12 accessions that were characterized as dwarf type; least Secondary branch, pod per plant, yield per plant and yield per hectare, whereas medium days to 50% flowering days, days to maturity and primary branch [19]. Cluster II, consisted of 20 accessions which was distinguished by its maximum days to 50% flowering days, days to maturity, plant height, secondary branch, and 100 Seed weight, as well as by its medium and minimal primary branch yields per plot and yield per hectare. Cluster III constituted 8 accessions, and characteristics: maximum primary branch, pods per plant, yields per plant, and yields per hectare; medium plant height, secondary branch, and 100 Seed Weight (TGW); minimum days to 50% flowering days; and minimum days to maturity plant [20].

Cluster II consisted of maximum accessions indicating that the accession had narrowed genetic divergence. The similarity in the parental population, which had evolved, might be the cause of genetic uniformity. However, the unidirectional selection potential for one particular trait or a group of linked traits in several places may produce similar phenotypes which can be aggregated into one cluster irrespective of their geographic origin. Cluster I had minimal secondary branches, plant heights, and seed weights of 100, whereas Cluster II had maximum plant heights, secondary branches, and seed weights of 100, while Cluster III was distinguished by the highest possible pods per plot, yield per hectare, and yield per plot [21] The intra cluster distance varied from 475 to 953. Cluster III (953) had the greatest intra cluster distance (Table 4). As a result, Cluster III had the most varied accessions. When accessions from clusters with the greatest inter-cluster distance are crossed, the resulting hybrids may have a strong heterotic response and produce better recombinants.

**Table 1:** Standard deviation (SD), Mean performance of yield, and CV (%) of accession.

| Characteristics | Maximum | Minimum | Range | Mean | SD | CV% |
|---|---|---|---|---|---|---|
| PH | 43 | 34 | 9 | 83.91 | 4.7 | 0.04 |
| DF | 67 | 52 | 15 | 17.5 | 10 | 0.57 |
| DM | 93 | 78 | 15 | 57.91 | 3.7 | 0.06 |
| PB | 9.3 | 2 | 7.3 | 38.98 | 2.4 | 0.06 |
| SB | 14 | 5.9 | 8.1 | 3.35 | 1.7 | 0.49 |
| PPP | 142.4 | 24.8 | 117.6 | 8.83 | 2.4 | 0.27 |
| TGW | 55.9 | 25.9 | 30 | 61.57 | 28.9 | 0.47 |
| YPP | 525.1 | 99.5 | 425.6 | 32.48 | 8.4 | 0.26 |
| YPH | 1748 | 329.3 | 1418.7 | 291.22 | 99.7 | 0.34 |

**Table 2:** Grouping of accessions in three clusters.

| Cluster | Number of accessions | Entry number accessions | Entry accession |
|---|---|---|---|
| cluster I | 12 | 5,6,7,8,10,17,27, | EBI-26919, EBI-26920, EBI-26921, EBI-26923, EBI-26925, EBI-30347, EBI-30318, EBI-30319, EBI-30320, EBI-30329, EBI-29062, Check 4 |
| | | 28,29,30,31,36 | |
| Cluster II | 20 | 1,2,3,4,9,11,12, | EBI-26915, EBI-26916, EBI-26917, EBI-26918, EBI-26924, EBI-26926, EBI-30343, EBI-30344, EBI-30349, EBI-30348, EBI-30308, EBI-30311, EBI-30312, EBI-30316, EBI-30317, EBI-29063, Check 1, Check 2, Check 5, Check 7 |
| | | 13,19,20,21,22, | |
| | | 23,25,26,32,33,34,37,39 | |
| Cluster III | 8 | 14,15,16,18,24,40,38,35 | EBI- 30346, EBI-30342, EBI-30345, EBI-30350, EBI-30315, Check 8, Check 6, Check 3 |

**Table 3:** Cluster mean performances of nine quantitative traits.

| Cluster | DF | DM | PH | PB | SB | PPP | TGW | YPP | YPH |
|---|---|---|---|---|---|---|---|---|---|
| I | 57 | 83 | 38 | 3.3 | 6 | 23.8 | 28.2 | 98.5 | 328.3 |
| II | 58 | 84 | 42 | 2.3 | 11.5 | 106.8 | 30.3 | 310.7 | 1035.7 |
| III | 55 | 81 | 40 | 3.4 | 11 | 141.4 | 29.4 | 524.1 | 1747 |
| Mean | 57 | 83 | 40 | 3 | 9.5 | 90.7 | 29.3 | 311.1 | 1037 |

**Table 4:** Intra and Inter-cluster distances of three clusters.

| | cluster I | Cluster II | Cluster III |
|---|---|---|---|
| cluster I | | 225625 (475) | 908209 (953) |
| Cluster II | | | 229441 (479) |
| Cluster III | | | 908209 (953) |

**Table 5:** Correlation of quantitative traits with grain yield.

| | DF | DM | PH | PB | SB | PPP | TGW | YPP | YPH |
|---|---|---|---|---|---|---|---|---|---|
| DF | 1 | -0.17 | -0.17 | -0.03 | -0.69 | -0.19 | -0.01 | -0.13 | -0.1 |
| DM | | 1 | 1 | -0.08 | -0.15 | -0.05 | -0.04 | -0.09 | -0.15 |
| PH | | | 1 | -0.08 | -0.15 | -0.05 | -0.04 | -0.09 | -0.15 |
| PB | | | | 1 | -0.12 | -0.18 | -0.03 | 0.18 | 0.25 |
| SB | | | | | 1 | 0.59 | 0 | 0.43 | 0.08 |
| PPP | | | | | | 1 | 0.35 | 0.3 | 0.21 |
| TGW | | | | | | | 1 | -0.24 | 0.64 |
| YPP | | | | | | | | 1 | -0.12 |
| YPH | | | | | | | | | 1 |

Clusters are extremely dissimilar from one another. The genotypes of higher intra-and inter-cluster distances have more genetic divergence than the genotypes of minimum intra-and inter-cluster distance (Table 4).

### Correlation of accessions quantitative traits

The quantitative traits correlation was characterized and presented in Table 5. As result indicated that significantly strong positive correlation were observed between days to 75% maturity with plant height(r=1.00) followed by 100 seed weight with yield per hectare(r=0.64); secondary branch with pods per plant(r=0.59),while weak and negative correlation were observed between days to 50% flowering day with secondary branch; 100 seed weight with yield per plot; pods per plot with days to 50% flowering days; primary branch with pods per plot but no correlation were observed between secondary branch and 100 seed weight [22].

## Conclusion

In conclusion, the majority of accessions had pink flowers and an erect plant growth type. The majority of accessions had rough seed texture and reddish-brown to brown seeds color. All accessions were identified as early flowering dates and absences of seed shattering, but no late flowering dates were seen. Days to 50% flowering, Secondary branch, 100 Seed weight, and Yield per hectare were found to have the largest coefficients of variation (CV). The plant height, primary branch, and days to 75% maturity were shown to have the lowest coefficients of variance. Thirty-two accessions had flowering later than the check varieties while seven accessions have matured earlier and twenty-five accessions later matured than the check varieties. Compared to check varieties, 32 accessions produced more secondary branches and 24 accessions produced more pods per plant than check varieties. The highest 142.4 pods per plant was recorded for EBI-30345 with better yield per plot (524.1) and yield per hectare (1748) compared to all check varieties. Cluster I was having a minimum secondary branch, plant height, and 100 seed weight; Cluster II was having a maximum plant height, secondary branch, and 100 seed weight; and Cluster III having a maximum pods per plot, yield per hectare, and yield per plot. Cluster III had the highest intra cluster distance (953). The most divergent accessions were those that belonged to cluster III. As a result of the analysis, a significant and strong positive correlation was found between the days to 75% maturity and plant height (r=1.00); however, there was no correlation found between the secondary branch and 100 seed weight (r=0.00). Weak and negative correlations were found between the yield per plot and 100 seed weight (r=-0.24). Characterizations of 32 chickpea accessions revealed better yield, environmental tolerance, and resistance when compared to control variety. There was no appreciable morphological change of accessions when plot size and block replication number were increased in the same geographic area and environmental circumstances. The results of this study may be applied to the breeding program for developing improved chickpea cultivars and combining desired genetic features to meet the challenge of creating breeder variations for climate-smart crops.

## Recommendation

- To estimating the genetic parameters for the character can help with crop development programs and hybridization through allowing us to see how the environment impacts the traits and how we can use them further.
- Morphological characterization may be helpful in creating core collections at gene banks so that accessions are more easily available to breeders.
- To use marker-based accession identification and characterization to protect the integrity of variants for the future gain of breeders, farmers, and consumers.

### Authors' Contributions

Authors were involved in data collection, analysis, drafting of manuscript and approved of manuscript for publishing.

### Competing Interests

Authors declare that there are no competing interests.

### Availability of Data and Material

The data were available within the article and author hands.

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