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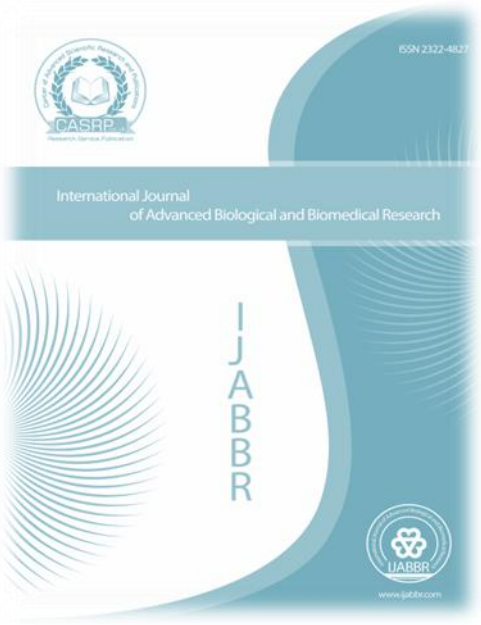

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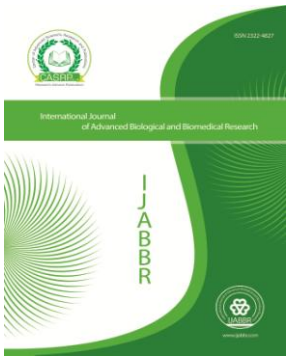

**Original Article** **Open Access**

# Morpho-Physiological Characterization Related to Drought Tolerance of Common Bean (*Phaseolus Vulgaris* L.) Genotypes

**Alemneh Mideksa Egu*** **and Kassahun Tesfaye**

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**Abstract**

Drought is one of the limiting factor in common bean, development of common bean varieties that adapted to drought situations is the main focus for improving food crops. In this study, 25 genotypes of common beans (*Phaseolus vulgaris* L.) were grown under drought stress and non-stress conditions. The field work was conducted at Melkassa Agricultural Research Center during the off-season that laid on a triple lattice design with three replications. A number of drought indicator characteristics were measured from germination to harvesting stages. The stressed genotypes showed a significant reduction in all quantitative characters such as chlorophyll content, stomatal conductance, days to 50% flowering, days to 90% maturity, seeds per pod, pods per plant, 100-seed weight, pod harvest index and harvest index. Harvest index recorded the highest heritability (67.01) and the highest genetic advance (22.57%) under stress condition, respectively. The study confirmed the existence of variation among common bean genotypes when subjected to drought stress and such variation could be utilized in the improvement of common bean genotypes under drought environmental conditions.



**Keywords:** Correlation coefficient, Drought, Genetic advance, Heritability, *Phaseolus vulgaris*

## 1. Introduction

Common bean (*Phaseolus vulgaris* L.) is the world's most important food legume. It grown in the tropics and subtropics, have large coverage due to its low input agricultural systems, and as an export crop (Darkwa et al.,

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2016). It is a key source of dietary protein, rich in iron, fibers, and polysaccharide carbohydrates (Beebe et al., 2013). As legumes, they act as crop rotation that means they are useful in improving soil fertility through their symbiotic nitrogen fixing ability (Ambachew et al., 2015).

Adaptation of common bean to different environmental conditions around the world has resulted in the evolution of extensive genetic variation for nutrient efficiency in this crop (Tilahun et al., 2004). Consequently, its rich and apparent genetic diversity for stress tolerance makes it an excellent crop model plant (Gómez, 2004). Drought, dry soil due to lack of rain or delayed irrigation, is the most important limiting factor for crop production and the severe problem in many regions of the world (Beebe et al., 2013). Drought affects water-use efficiency and utilization of most major and minor nutrients (Darkwa et al., 2016).

The effects of drought stress vary depending on the frequency, duration, intensity of stress, growth stages affected and can be amplified by other stresses such as poor soils, disease, and heat (Tilahun et al., 2004; Muñoz-Perea et al., 2007; Ambachew et al., 2015). In common bean, excessive abortions occur during pre-flowering and reproductive periods (Nielsen and Nelson, 1998). Thus, the growth stages as affected by intensity and duration of drought determine the extent of losses in seed yield and quality (Abebe Hinkossa et al., 2013). Most commonly responses of common bean to drought stress, including rooting pattern (Beebe et al., 2008, 2013), capacity to partition a greater proportion of carbohydrates to seed under stress (Subbaro et al., 1995; Singh et al., 2007), reduced stomata conductance and leaf area, and the capability to maintain turgor through osmotic adjustment (Tilahun et al., 2004; Beebe et al., 2013). The most sensitive stages to grain filling were at flowering and ten days prior to flowering. It was noted that post-flowering heat stress caused yield losses up to 50% due to reduced seed filling duration (Bernier et al., 2007; Beebe et al., 2013).

Drought stress condition causes significant reduction on grain yield and biological yield of common bean (Tar'an and Singh, 2002). Direct selection for yield under favorable or water-limited conditions is the selection strategy that has been the most commonly used by crop breeders to improve yield in water-limited environments (Tilahun et al., 2004). Drought induces measures drought based on the loss of yield under drought tolerant genotypes. Drought susceptibility of a genotype is often measured as a function of the reduction in yield under drought stress. Drought stress affects the yield components such as number of pods per plant, number of seeds per pod, seed weight and harvest index (Ambachew et al., 2015; Darkwa et al., 2016).

Heritability is a measure of the value of selection for particular characters and an index of their transmissibility (Ali et al., 2006). Alghamdi (2007) observed that the highest estimates of heritability were recorded for number of pods and number of seeds per plant. High heritability was recorded by days to maturity in common bean. High estimates of heritability indicated that selection based on mean would be successful in improving these traits. The low values of heritability in a broad sense and in a narrow sense in both drought stress and non-stress environments indicated medium chances of transmitting to the offspring that determine bean productivity and improvement of the traits.

Many researches were made concerning drought resistance common bean varieties, but the characterization of the morpho-physiological attributes to drought tolerance using the selected varieties still remain the subject of future investigation. This study was focused to measure the phenotypic variability of these traits under water-stress and non-stress conditions; to determine the relationship between these traits and yield related traits under drought; and to estimate heritability and genetic advance and assess their potential drought resistance of common bean genotypes.

## 2. Materials and methods

### 2.1. Description of the study area

The field experiment was conducted at Melkassa Agricultural Research Center (MARC) during off-season. Melkassa Agricultural Research Center elevation is 1550masl with a latitude of 8°24'N and a longitude 39°21'E. It has an annual maximum temperature ranging from 28-30 °C and receives an average annual rainfall of 468 mm, which is erratic and uneven in distribution. The site is dominated by Loam and clay loam soil textures.

### 2.2. Experimental procedure and design

Twenty five total genotypes (5 x 5) were laid in simple lattice design separately for drought stress (DS) and non-stress (NS) conditions. Each genotype was grown in two rows of 3m length kept at 0.6m apart. The distance

between plants within a row was 0.1m. Plants of both stressed and non-stressed treatments received full irrigation from planting to flowering stage. Drought stress was initiated at the late flowering stage of the stressed treatment. Non-stressed treatments received full irrigation until physiological maturity. Other cultural practices used were similar under stressed and non-stressed conditions.

**2.3. Parameters measured**

Growth, physiological and yield related traits were measured on five randomly selected plants per plot. Days to flowering and maturity were determined from the whole plot. Procedures used to measure the various parameters are described as follows:

1) Vegetative vigor: Vegetative vigor was estimated through visual observation. Each plot was assessed for general growth at four weeks after emergence. Scoring was made on a scale of 1 to 5, whereby 1 = very poor, 2 = poor, 3 = average, 4 = good, 5 = very good (Tilahun et al., 2004).

2) Above ground biomass weight (g plant$^{-1}$): Above ground part of randomly selected plants were harvested and separated into vegetative and reproductive parts immediately after fresh weights were taken. Above ground dry weight was determined by adding up the various plant parts dried at 80$^0$C for 48h. Biomass partitioning ability of the genotypes was evaluated by computing the ratio of reproductive structures (pods / pod walls + seeds) to vegetative biomass (leaf + stem dry weight).

3) Days to 50% flowering: Number of days taken by each genotype from the day of planting for the day on which 50% of the plants in a plot opened at least one flower per plant.

4) Days to 90% maturity: Determined as the number of days from date of planting to the date when 90% of the plants in each plot attained physiological maturity.

5) Chlorophyll content: It was measured using a non-destructive, handheld chlorophyll meter (SPAD-502 chlorophyll meter). SPAD-502 determines the relative amount of chlorophyll present in the leaf by measuring the absorbance of the leaf in two wavelength regions. Chlorophyll has absorbance peaks in the blue (400-500nm) and red (600-700nm) regions, using these two transmittances, the meter calculates a numerical SPAD value, ranging from 0 to 80 is proportional to the amount of chlorophyll present in the leaf. SPAD value was measured on a fully expanded young leaf of five plants in each row.

6) Stomatal conductance (m mol $m^{-2}s^{-1}$): Stomatal conductance was measured on fully expanded young leaves from five plants with a leaf porometer.

7) Pod Harvest Index (PHI): The PHI for each genotype is determined as ratio of dry weight of pods to dry weights of vegetative parts at mid-pod filling stage. Pod Harvest Index (%) = [pod weight] / [leaf weight + stem weight +pod weight] x 100.

8) Pods per plant: Determine the average number of pods per plant by randomly harvesting 5 plants in a plot; count the number of pods at physiological maturity.

9) Seeds per pod (count): Determined as the average number of seeds per pod of sampled plants.

10) 100-seed weight (g): Determined as weight of hundred randomly sampled seeds from all plants harvested per plot.

11) Seed yield (g $m^{-2}$) was calculated as the product of yield component (number of pods per plant, number of seeds per pod and seed weight).

12) Harvest Index (%): Was determined as the ratio of seed yield to the above ground dry weight (stem + leaves + pod + seed) at harvest.

**2.4. Statistical analysis**

The analysis of variance was computed for all parameters considered using SAS (v 9.1.3) GLM procedure (SAS Institute, 2004) software to demonstrate the existence of differences among the genotypes under the two growth conditions. The genetic parameters were computed using SPSS software.

## 3. Results and discussion

### 3.1. Effect of drought stress on chlorophyll content, stomatal conductance and pod harvest index

Mean squares for treatment and water regime were highly significant ($P$<0.01) for chlorophyll content, stomatal conductance and pod harvest index (Table 1). On the other hand, mean squares for replication, block, water regime, and treatment and water regime-treatment interactions were highly significant ($P$<0.01) for stomatal conductance. Mean squares for treatment-water regime interactions were significant ($P$<0.05) for pod harvest index.

**Table 1**
Mean of square for replication, block, water regime, and treatment and water regime-treatment interactions of common bean for chlorophyll content, stomatal conductance and pod harvest index at late flowering.

| Source of variation | DF | Chlorophyll content | Stomatal conductance | Pod harvest index |
|---|---|---|---|---|
| Replication | 2 | 2.68 | 415.81** | 46.44 |
| Block | 24 | 7.10 | 586.99** | 46.67 |
| Water regime | 1 | 1247.62** | 239704.09** | 3311.62** |
| Treatment | 24 | 11.56** | 1992.94** | 94.84** |
| Water regime x Treatment | 24 | 6.14 | 2137.59** | 15.49* |
| Error | 98 | 4.57 | 70.16 | 35.95 |

*, ** Significant at P<0.001 and P<0.05 respectively.

The effect of drought stress on chlorophyll content, stomatal conductance and pod harvest index were highly significant (Table 2). Drought stress caused a significant reduction on chlorophyll content that ranged from 5% to 20%. The highest chlorophyll content was recorded by Awash-1 genotype (51.3) under non-stress and by Dinknesh genotype (47.0) under drought stress. Drought stress also caused a significant reduction on stomatal conductance that ranged from 30% to 70.0%. The highest stomatal conductance was observed on Chercher genotype and the lowest was observed on Awash-2 genotype under drought stress. Ambachew et al. (2015) reported similarly that drought stress affects stomatal conductance, chlorophyll content (Lizana et al., 2006), and relative water content (Chaves et al., 2009). These mechanism positive associations with yield, pod number, seed number, total biomass under stress condition. Drought stress also caused a significant reduction on pod harvest index that ranged from 5% to 21%. The highest reduction was on Cranscope genotype, whereas the lowest reduction was by Deme genotype under drought stress. The highest seed yield was scored by Awash-Melka genotype (112.7g $m^{-2}$) and the lowest by Cranscope genotype (75.5g $m^{-2}$) under drought stress (Table 2). When common bean exposed to drought stress, the chlorophyll content of the leaves changed in order to reduce the extent of the absorbed light.

### 3.2. Effect of drought stress on seed yield and yield components

Drought stress induced reduction in pod per plant that ranged from 11.5% to 40.7% (Table 3). The highest pod per plant reduction was observed in Awash-1 genotype (40.7 %). Drought stress also caused a significant reduction on seed per pod that ranged from 6.0 to 47.5%. The highest seed per pod reduction was observed in Tabor genotype (47.5 %). Drought stress also induced reduction in hundred seed weight that ranged from 5 % to 30%. Darkwa et al. (2016) reported that drought stress affects the yield components such as number of pods per plant, number of seeds per pod, seed weight and harvest index (Tar'an and Singh, 2002; Mideksa, 2016).

### 3.3. Heritability and genetic advance

Heritability of the different traits measured ranged from 19.01 to 67.07% under drought stressed while it ranged from 32.0 to 90.01% under non-stress condition. Days to 50% flowering showed the lowest heritability under non-stressed (32.0%) whereas chlorophyll content had the lowest heritability under stressed treatments (19.01). Harvest index had the highest heritability under stress (67.01) while seeds per pod had the highest heritability (90.0) under non-stress growing conditions (Table 4). Similar to the present result, Alghamdi (2007) observed that the highest estimates of heritability were recorded for number of pods and the number of seeds per plant. Scully et al. (1991) reported high heritability value for seed yield, above ground biomass and harvest index.

High estimates of heritability indicated that selection based on mean would be successful in improving these traits. The low values of heritability in both drought stress and non-stress environments indicated medium chances of transmitting to the offspring that determine bean productivity and improvement of the traits.

The quantitative traits also exhibit significant variation in genetic advance in this study. It ranged from 6.06 to 22.57% under drought stress and 12.60 to 28.07% under non-stress conditions. Seeds per pod had the lowest genetic advance under stress condition (6.06%) and harvest index (22.57%) had the highest under stress condition (Table 4). Bello et al. (2012) similarly reported grain yield and its component characters were highly significant. For non-stress treatments, days to 50% flowering (12.60%) had the lowest and seeds per plants (28.07) had the highest genetic advance (Ogunniyan and Olakojo, 2014).

**Table 2**

Effect of drought stress in chlorophyll content, stomatal conductance and pod harvest Index of twenty five common bean genotypes.

| | Chlorophyll content | | Stomatal conductance | | Seed yield | | Pod harvest index | |
|---|---|---|---|---|---|---|---|---|
| Genotype | Non-stress | Stress | Non-stress | Stress | Non-stress | Stress | Non-stress | Stress |
| Argene | 50.0 $^{a-c}$ | 46.7 $^{ab}$ | 135.5 $^{g}$ | 46.2 $^{j}$ | 188.8 $^{a-c}$ | 82.5 $^{cd}$ | 76.2 $^{a-c}$ | 64.5 $^{a-c}$ |
| AwashMelka | 49.6 $^{a-d}$ | 43.8 $^{a-c}$ | 178.6 $^{cd}$ | 58.6 $^{g}$ | 181.7 $^{bc}$ | 112.7 $^{d}$ | 70.1 $^{a-e}$ | 57.4 $^{ab}$ |
| Awash-1 | 49.9 $^{a-c}$ | 40.5 $^{c}$ | 193.9 $^{ab}$ | 63.1 $^{f}$ | 191.1 $^{b}$ | 85.7 $^{cd}$ | 69.7 $^{a-e}$ | 62.2 $^{a-c}$ |
| Awash-2 | 51.3 $^{a}$ | 46.9 $^{a}$ | 142.4 $^{e-g}$ | 42.6 $^{k}$ | 166.6 $^{c-e}$ | 75.3 $^{d}$ | 66.6 $^{de}$ | 56.4 $^{c}$ |
| Batu | 47.5 $^{cd}$ | 42.8 $^{a-c}$ | 85.4 $^{j}$ | 54.9 $^{h}$ | 190.2 $^{ab}$ | 85.9 $^{cd}$ | 73.3 $^{a-e}$ | 65.9 $^{a-c}$ |
| Chercher | 50.5 $^{ab}$ | 43.0 $^{a-c}$ | 139.9 $^{fg}$ | 97.9 $^{a}$ | 193.8 $^{a}$ | 88.2 $^{b-d}$ | 73.1 $^{a-e}$ | 66.9 $^{a-c}$ |
| Chore | 48.5 $^{b-d}$ | 41.9 $^{a-c}$ | 138.4 $^{fg}$ | 58.2 $^{g}$ | 171.7 $^{d}$ | 79.1 $^{d}$ | 74.5 $^{a-e}$ | 64.1 $^{a-c}$ |
| Cranscope | 48.9 $^{a-d}$ | 43.7 $^{a-c}$ | 109.2 $^{hi}$ | 63.1 $^{f}$ | 147.5 $^{e}$ | 75.5 $^{e}$ | 77.8 $^{a}$ | 75.1 $^{a}$ |
| Deme | 48.3 $^{b-d}$ | 40.9 $^{c}$ | 136.3 $^{g}$ | 94.6 $^{c}$ | 187.3 $^{a-c}$ | 93.3 $^{a-d}$ | 65.2 $^{e}$ | 55.2 $^{c}$ |
| Dinknesh | 49.7 $^{a-c}$ | 47.0 $^{a}$ | 139.8 $^{fg}$ | 45.2 $^{jk}$ | 190.7 $^{ab}$ | 98.6 $^{a-d}$ | 69.3 $^{a-e}$ | 64.1 $^{a-c}$ |
| Dursitu | 48.8 $^{a-d}$ | 39.8 $^{c}$ | 129.4 $^{gh}$ | 74.0 $^{d}$ | 172.3 $^{d}$ | 91.3 $^{a-d}$ | 72.7 $^{a-e}$ | 66.4 $^{a-c}$ |
| GobeRasha | 47.9 $^{b-d}$ | 43.9 $^{a-c}$ | 189.4 $^{ab}$ | 82.7 $^{c}$ | 164.9 $^{c-e}$ | 88.5 $^{b-d}$ | 73.1 $^{a-e}$ | 65.8 $^{a-c}$ |
| Gofta | 48.3 $^{b-d}$ | 41.4 $^{bc}$ | 145.8 $^{e-g}$ | 81.2 $^{c}$ | 165.9 $^{c-e}$ | 91.2 $^{a-d}$ | 74.1 $^{a-e}$ | 62.0 $^{a-c}$ |
| IBADO | 48.4 $^{b-d}$ | 42.6 $^{a-c}$ | 146.7 $^{e-g}$ | 60.7 $^{fg}$ | 167.7 $^{c-e}$ | 94.6 $^{a-d}$ | 77.1 $^{ab}$ | 71.0 $^{ab}$ |
| Melkie | 48.8 $^{a-d}$ | 41.9 $^{a-c}$ | 164.9 $^{de}$ | 62.7 $^{f}$ | 170.1 $^{cd}$ | 96.9 $^{a-d}$ | 74.9 $^{a-d}$ | 66.4 $^{a-c}$ |
| Melkadima | 49.3 $^{a-d}$ | 46.6 $^{ab}$ | 160. 7 $^{d-f}$ | 95.1 $^{ab}$ | 195.8 $^{b-d}$ | 100.7 $^{a-d}$ | 71.1 $^{a-e}$ | 56.4 $^{c}$ |
| Mexican 142 | 48.5 $^{b-d}$ | 39.9 $^{c}$ | 104.2 $^{ij}$ | 74.9 $^{d}$ | 174.7 $^{a}$ | 97.8 $^{a-d}$ | 72.9 $^{a-e}$ | 68.4 $^{a-c}$ |
| Morka | 47.9 $^{cd}$ | 43.2 $^{a-c}$ | 165.3 $^{de}$ | 69.4 $^{e}$ | 175.3 $^{b-d}$ | 100.9 $^{a-d}$ | 73.1 $^{a-e}$ | 58.3 $^{ab}$ |
| Nasir | 47.1 $^{d}$ | 42.1 $^{a-c}$ | 97.2 $^{ij}$ | 61.1 $^{fg}$ | 170.3 $^{cd}$ | 99.6 $^{a-d}$ | 73.9 $^{a-e}$ | 64.4 $^{a-c}$ |
| Red wolayta | 49.6 $^{a-d}$ | 42.8 $^{a-c}$ | 145.6 $^{e-g}$ | 68.5 $^{e}$ | 167.9 $^{c-e}$ | 99.2 $^{a-d}$ | 67.5 $^{c-e}$ | 55.4 $^{c}$ |
| Roba-1 | 48.4 $^{b-d}$ | 40.7 $^{c}$ | 139.1 $^{fg}$ | 74.1 $^{d}$ | 183.0 $^{bc}$ | 110.5 $^{a-d}$ | 68.1 $^{b-e}$ | 58.3 $^{ab}$ |
| Tabor | 47.9 $^{cd}$ | 40.0 $^{c}$ | 226.5 $^{a}$ | 63.4 $^{f}$ | 165.7 $^{c-e}$ | 101.6 $^{a-d}$ | 69.1 $^{a-e}$ | 56.4 $^{c}$ |
| Nazareth-2 | 48.3 $^{b-d}$ | 43.5 $^{a-c}$ | 203.5 $^{b}$ | 44.0 $^{jk}$ | 166.8 $^{c-e}$ | 101.8 $^{a-c}$ | 72.7 $^{a-e}$ | 63.8 $^{a-c}$ |
| SER-119 | 48.5 $^{b-d}$ | 44.1 $^{a-c}$ | 135.6 $^{g}$ | 50.4 $^{i}$ | 160.5 $^{de}$ | 100.1 $^{ab}$ | 76.4 $^{a-c}$ | 63.2 $^{a-c}$ |
| SER-125 | 49.0 $^{a-d}$ | 46.9 $^{a}$ | 101.8 $^{ij}$ | 69.8 $^{e}$ | 161.9 $^{de}$ | 102.3 $^{a}$ | 75.4 $^{a-d}$ | 64.9 $^{a-c}$ |

Mean comparison of Duncan test at 5% probability.

**Table 3**

Effect of drought stress on seed yield components of common bean genotypes grown at Melkassa.

| | Pod per plant | | | Seed per pod | | | 100-Seed weight | | |
|---|---|---|---|---|---|---|---|---|---|
| Genotype | Control | Stress | PR | Control | Stress | PR | Control | Stress | PR |
| Argene | 30.7±2.2 | 25.2±2.7 | 20.8 | 5.0±0.1 | 4.7±0.3 | 6.0 | 27.3±0.9 | 24.1±0.1 | 10.7 |
| AwashMelka | 30.8±1.0 | 20.8±8.0 | 11.2 | 6.1±0.4 | 4.7±0.4 | 22.9 | 19.3±0.6 | 18.1±0.6 | 9.2 |
| Awash-1 | 40.6±0.9 | 28.9±3.4 | 10.5 | 6.1±0.4 | 4.2±0.1 | 31.1 | 23.0±3.1 | 14.6±0.3 | 18.5 |
| Awash-2 | 32.7±1.3 | 20.9±1.9 | 32.0 | 6.6±0.5 | 4.4±0.2 | 33.3 | 22.3±1.0 | 19.5±0.2 | 12.6 |
| Batu | 35.0±5.0 | 25.2±19 | 25.0 | 4.8±0.3 | 3.9±0.3 | 18.8 | 31.1±1.4 | 26.8±1.3 | 13.8 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Chercher | 37.6±1.5 | 30.3±3.8 | 20.4 | 6.2±0.2 | 4.4±0.3 | 29.0 | 19.0±0.4 | 15.4±6.5 | 19.0 |
| Chore | 40.1±1.7 | 30.0±3.8 | 27.0 | 6.2±0.5 | 4.2±0.1 | 32.3 | 24.3±0.3 | 20.6±1.1 | 15.2 |
| Cranscope | 25.4±1.5 | 15.2±5.8 | 40.7 | 5.2±0.2 | 4.5±0.1 | 13.5 | 27.9±1.1 | 25.0±0.8 | 10.4 |
| Deme | 25.7±3.3 | 23.1±5.3 | 13.5 | 4.9±0.1 | 4.3±0.3 | 12.2 | 46.5±0.4 | 43.1±0.1 | 5.2 |
| Dinknesh | 28.9±2.1 | 19.8±1.1 | 29.0 | 5.8±0.1 | 4.3±0.1 | 25.9 | 27.4±0.9 | 23.7±0.7 | 14.5 |
| Dursitu | 28.8±6.0 | 18.0±2.5 | 38.5 | 5.3±0.5 | 4.0±0.5 | 24.5 | 39.4±2.5 | 34.6±4.5 | 12.5 |
| GobeRasha | 32.3±3.4 | 20.8±3.1 | 34.5 | 6.0±0.3 | 4.6±0.2 | 23.3 | 22.8±0.5 | 20.4±0.9 | 10.5 |
| Gofta | 25.8±0.4 | 20.2±5.1 | 19.5 | 5.0±0.2 | 4.0±0.2 | 20.0 | 43.2±1.1 | 29.8±4.5 | 30.0 |
| IBADO | 26.4±3.3 | 17.8±1.7 | 32.6 | 5.3±0.2 | 4.1±0.2 | 22.6 | 43.2±2.0 | 35.7±2.8 | 17.4 |
| Melkie | 32.4±4.2 | 24.1±4.3 | 26.0 | 6.2±0.3 | 4.6±0.3 | 25.8 | 21.2±0.4 | 20.3±0.0 | 8.2 |
| Melkadima | 25.3±0.6 | 22.3±2.2 | 11.9 | 5.6±0.1 | 4.1±0.6 | 26.8 | 23.3±0.4 | 22.2±0.7 | 6.7 |
| Mexican 142 | 30.9±1.6 | 23.1±4.6 | 25.2 | 6.4±0.3 | 3.9±0.4 | 39.1 | 20.9±0.3 | 18.3±1.1 | 12.4 |
| Morka | 30.3±2.9 | 23.7±5.3 | 20.1 | 7.2±0.5 | 4.7±0.7 | 34.7 | 24.3±1.2 | 23.1±0.3 | 5.0 |
| Nasir | 28.0±2.8 | 22.0±6.5 | 20.9 | 6.1±0.6 | 3.9±0.4 | 36.1 | 25.3±0.7 | 24.0±1.9 | 5.1 |
| Red wolayta | 29.0±4.1 | 19.1±2.5 | 33.5 | 6.1±0.7 | 4.0±0.1 | 34.4 | 17.7±0.4 | 16.3±1.5 | 7.9 |
| Roba-1 | 34.0±7.1 | 26.0±3.5 | 23.5 | 6.4±0.5 | 3.8±0.3 | 40.6 | 17.7±0.6 | 15.3±0.6 | 13.6 |
| Tabor | 26.2±3.6 | 18.4±2.9 | 30.0 | 5.9±0.3 | 3.1±0.2 | 47.5 | 21.8±0.7 | 20.2±0.8 | 7.3 |
| Nazareth-2 | 32.7±3.3 | 20.2±0.9 | 38.2 | 6.5±0.4 | 4.3±0.3 | 33.8 | 18.9±0.8 | 16.2±0.5 | 20.1 |
| SER-119 | 28.0±1.9 | 18.1±2.8 | 30.0 | 6. 7±0.3 | 5.1±0.0 | 23.9 | 18.1±0.1 | 17.1±1.3 | 5.5 |
| SER-125 | 38.2±3.2 | 21.9±1.8 | 42.0 | 5.9±0.3 | 4.8±0.2 | 18.6 | 20.9±1.1 | 19.3±0.1 | 8.1 |

**Table 4**

PCV and GCV, heritability and genetic advance in common bean genotypes grown under drought stress and non-stress conditions.

| Parameters | Growth conditions | PCV | GCV | Heritability | Genetic advance |
|---|---|---|---|---|---|
| AGB | Stress | 22.35 | 11.90 | 53.09 | 21.02 |
| | Non-stress | 29.00 | 15.38 | 67.01 | 22.01 |
| DFF | Stress | 10.01 | 2.01 | 29.01 | 10.01 |
| | Non-stress | 12.0 | 4.04 | 32.0 | 12.60 |
| DM | Stress | 2.92 | 4.40 | 37.01 | 15.10 |
| | Non-stress | 5.90 | 8.46 | 57.28 | 19.07 |
| CHC | Stress | 12.21 | 15.60 | 19.01 | 7.30 |
| | Non-stress | 20.21 | 17.76 | 80.70 | 26.25 |
| SC | Stress | 3.50 | 5.81 | 65.57 | 20.53 |
| | Non-stress | 15.30 | 9.00 | 69.14 | 22.20 |
| PHI | Stress | 12.30 | 9.01 | 46.04 | 17.24 |
| | Non-stress | 14.01 | 11.08 | 71.94 | 27.83 |
| PPP | Stress | 20.20 | 4.8 | 56.15 | 22.06 |
| | Non-stress | 29.01 | 19.33 | 76.94 | 24.09 |
| SPP | Stress | 24.02 | 21.15 | 32.22 | 6.06 |
| | Non-stress | 36.40 | 3.07 | 90.01 | 28.07 |
| HSW | Stress | 27.01 | 18.80 | 67.07 | 20.99 |
| | Non-stress | 30.31 | 6.58 | 57.46 | 22.29 |
| SY | Stress | 4.10 | 2.15 | 52.39 | 20.48 |
| | Non-stress | 6.20 | 3.30 | 81.61 | 26.02 |
| HI | Stress | 24.80 | 22.90 | 67.01 | 22.57 |
| | Non-stress | 27.20 | 15.73 | 72.90 | 25.64 |

AGB = Above ground biomass, DFF = Days to fifty % flowering, DM = Days to ninety % maturity, CHC = Chlorophyll content, SC = Stomatal conductance, PHI = Pod harvest index, PPP= Pod per plant, SPP = Seed per pod, HSW = 100-seed weight, SY = Seed yield, HI = Harvest index, PCV = Phenotypic coefficient variance, GCV = Genotypic coefficient variance.

## 4. Conclusion

Discovery of drought tolerance common bean genotypes is the basis for drought environmental areas. The study demonstrated that Awash-Melka was the most drought tolerant genotype, produced the highest seed yield under drought stress. In contrast, Cranscope had the lowest seed yield under drought stress, and this genotype can be considered the most drought-susceptible among all the genotypes. Still morphological comparisons of drought resistance in common bean remain an effective method, but have some limitations, including environmental factors, measurable characters and management practice. Therefore, there is the need of appropriate molecular markers like SNPs, SSR, RAPD, etc, for detection of better varieties that appropriate for drought environmental conditions.

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