Plant Science 2018: Genotype x environment interaction and yield stability of arabica coffee (*Coffea arabica* L.) genotypes- Lemi Beksisa, Ashenafi Ayano and Sentayew Alamerew-Jimma Agricultural Research Center, College of Agriculture and Veterinary Medicine-Jimma University

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Lack of suitable varieties that exhibit stable yield performances across wide ranges of environments because of significant Genotype x Environment Interaction (GEI) is the major factor among several production constraints contributing to low productivity of Arabica coffee in Ethiopia. In the present study, eleven advanced Limmu coffee genotypes were evaluated in eight environments (four locations over two years) to determine the existence of GEI and yield stability performances. The experiment was laid out in a randomized complete block design of two replications under all locations. Combined analysis of variance showed a highly significant effect of genotype by environment interaction indicating the differential yield response of genotypes across different environments. The major proportion of the variation explained by environments was 42.74% of the total variation. Nevertheless, the contribution of the genotypes to the total variance was much smaller than the environments and the genotype by environment interactions. This suggests that environmental variation, among other variance components was the major factor affecting the yield performance of coffee genotypes. To this effect, different stability models such as Additive Main effect and Multiplicative Interaction (AMMI), AMMI stability value, cultivar superiority index and yield stability index were used for the stability analysis. The first two Interaction Principal Component axis (IPCAs) of AMMI exhibited a highly significant effect and cumulatively contributed about 63.21% of the total interaction sum of squares which was greater than half of the total. This indicated the capability of the first two principal component axis for cross-validated variation explained by the interaction effect. Subsequently, the two high yielding genotypes, namely; G3 (L52/2001) and G9 (L55/2001), on an average, showed stable performance across environments and on the other hand, the study also illustrated the presence of location specific high yielding coffee genotype such as L56/2001 as a result of significant interaction of the genotypes with the environments. Regarding to test environments, Gera 2015/16 (E5) regarded as a more stable site for coffee bean yield improvement over the rest environments due to the IPCA score nearer to zero which is having little interaction effect, while Agaro 2015/16 (E7) was considered to be the most interactive environment. Based on the result of this study, coffee breeders or farmers would be recommended for wisely selecting either for location specific or wider adaptable coffee genotypes leading to substantial yield increment under Limmu coffee growing areas.

Arabica coffee is the most widely consumed and highly preferred international beverage mainly for its best quality and is also one of the most important agricultural commodities in the world contributing to more than 60% of the world coffee production (Van der Vossen and Bertrand, 2015). Particularly in Ethiopia, coffee cultivation plays a fundamental role both in the cultural and socio-economic life of Ethiopians. It represents the major agricultural export crop, providing 20 to 25% of the foreign exchange earnings (ECFF, 2015). The coffee sector contributes about 4 to 5% to the country's Gross Domestic Product (GDP) and creates hundreds of thousands of local job opportunities (EBI, 2014).

Ethiopia is the largest producer of coffee in sub-Saharan Africa and is the fifth largest coffee producer in the world next to Brazil, Vietnam, Colombia and Indonesia, contributing to about 7 to 10% of total world coffee production. The total area coverage of coffee in Ethiopia is estimated to be about 800,000 ha of land with an annual production capacity of 500,000

This work is partly presented at 6th Global Summit on Plant Science, October 29-30, 2018, Valencia, Spain.

tons of which about 95% is produced by 4 million small scale farmers (Berhanu et al., 2015). Despite the high genetic diversity of Arabica coffee and naturally suitable climate condition in Ethiopia, the coffee production and productivity is not yet fully improved. Lack of high yielding improved varieties for each agro ecological zones and lack of suitable varieties that exhibit stable performance across wide ranges of environments are the major constraints in coffee production and productivity in Ethiopia (Yonas and Bayetta, 2008). In Ethiopia, to increase production and productivity of coffee using stable varieties, the first adaptation tests across different environments was carried out by Mesfin and Bayetta (1987). The trials were conducted in different major coffee producing agro ecological zones of southwestern Ethiopia, Oromia Regional state at four specific places: Jimma, Agaro, Manna and Gera for two consecutive cropping seasons (2014/15 and 2015/16). The first three locations represent mid altitude, while Gera represents high land area. The experimental materials used in this study comprised 11 Arabica coffee (Coffea arabica L.) genotypes. The genotypes were the only common genotypes at all locations; obviously the trials consisting of thirteen genotypes and therefore, the genotypes which did not exist at all locations were not incorporated in this study. The genetic materials were selected from Limmu Kossa and Limmu Seka collection of 2001 based on their yield, cup quality and disease resistance during the initial investigation at Gera and Agaro research centers. Analysis of variance (ANOVA) was done for each location separately based on the the standard procedure developed for a randomized complete block design. Bartlett's (1974) test was used to determine the homogeneity of error variances between environments. Comparison of treatment means was done using least significant difference (LSD). A combined analysis of variance was done to determine the significant effects of the genotypes, environments and their interactions. The SAS version 9.2 (SAS, 2008) statistical software was used for statistical computations and estimation of differences among genotypes. The effects of the genotypes and environments as well as their interactions were determined from ANOVA. Analysis of genotype stability across eight environments (locations and years) was computed using Additive Main effect and Multiplicative Interaction (AMMI), AMMI stability value (ASV), cultivar superiority index (Pi) and yield stability index.

Combined analysis of variance exhibited highly significant difference among the genotypes. The finding showed significant effects of both environments and G x E interaction. The major proportion of the total variation in bean yield was explained by environments (42.75%) followed by G x E interaction (32.32%) and genotypes (9.31). The finding indicated that the genotypes G3 (L52/2001) and G9 (L55/2001) with high mean yield of 1558 and 1473 kg/ha-1, respectively proved to be the best in stability among the studied genotypes. On the other hand, environment, Gera 2015/16 (E5) showed average response to all genotypes, while Agaro 2015/16 (E7) exhibited non-additive behavior. Therefore, this study clearly indicated the possibility of exploiting the yield potential of Limmu coffee genotypes under its growing conditions either by using wider adaptable coffee types or location specific high yielder genotype under favorable environmental condition.

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