The objective of this study was to evaluate the effect of genotype by environment interaction (GEI) on lactation pattern and milk production traits in an Ethiopian dairy cattle population. The study was conducted in Bako and Holeta, 20 km east and southwest of Bahir Dar, respectively. Overall, 2,488 lactation milk records of 1,320 cows were obtained from Bako and Holeta Agricultural Research Centers in Ethiopia. The Bako Agricultural Research Center is located 250 km west of Addis Ababa at an altitude of 1,650 m above sea level. The center received a mean annual rainfall of 1,100 mm. The significant differences of 80% and 50% of the total variation centered from May to September. The area had a mean relative humidity of 55% and monthly mean temperature of 22.6°C, which varied seasonally, with an average monthly temperature of 21°C. The Holeta Agricultural Research Center is located 45 km west of Addis Ababa at an altitude of 2,400 m above sea level. It is situated in the central highlands of Ethiopia. It has an annual average rainfall of approximately 1,200 mm. The annual average temperature is 18°C and the average monthly relative humidity is 60% (Gebregziabher et al., 2013).

Four seasons were defined based on rainfall distribution and availability of grasses in the area. Each season corresponded to the growing period and was divided into two sub-seasons: dry season (March 20 to June 20) and wet season (July 21 to January 24). The dry season included the months of March and April, while the wet season included May to June, July to September, and October to January. The dry season was characterized by a significant reduction in rainfall and availability of grasses, which resulted in a decrease in the availability of forage. During the wet season, rainfall increased, and grasses were more available, providing a better grazing environment for the animals.

Feeding, Management, and Health Care. Herd feeding, management, and health care were described in previous reports for Holeta (Taye, 2003) and Bako (Gebremariam et al., 2003). Cows were fed based on a fixed diet, with the milk yield per cow during the lactation period, initial milk yield (IY), peak milk yield (PM), average milk yield per day (ADY), lactation length (LL), and days to peak (DP) being the key variables. The effect of GEI was tested using a fixed linear model that considered herd- environment 

RESULTS AND DISCUSSION

Lactation milk yield (LY), initial milk yield (IY), peak milk yield (PM), and average milk yield per day (ADY) were significantly different (P < 0.001) among herd-year-season (HYS), environment, cow breed group, and crossbreeding. The herd of Bako was studied with the highest mean milk yield (819.8 ± 243.2 kg), while the herd of Holeta was the lowest with a mean milk yield of 541.3 ± 216.1 kg. The peak milk yield (PM) and average milk yield per day (ADY) were highest in Holeta with 1132.0 ± 278.8 kg and 705.4 ± 276.1 kg, respectively. In contrast, the peak milk yield and average milk yield per day were lowest in Bako with 759.1 ± 215.2 kg and 362.2 ± 163.5 kg, respectively. The lactation length (LL) was significantly different among HYS, with Bako having the longest LL of 359.6 ± 82.2 days, while Holeta had the shortest LL of 270.1 ± 59.9 days. This indicates that cows in Bako had a longer lactation period than those in Holeta, which could be attributed to differences in environmental factors such as temperature and precipitation. The days to peak (DP) were highest in Bako with 114.7 ± 30.5 days, while Holeta had the lowest DP with 84.6 ± 26.1 days.

The interaction effects of herd × environment × breed group were significant for all traits, indicating that the milk yield and lactation characteristics were influenced by the combination of these factors. For example, the highest milk yield was observed in the crossbred group in Bako, while the purebred group had the highest milk yield in Holeta. Similarly, the peak milk yield and average milk yield per day were highest in the crossbred group in Bako, while the purebred group had the highest values in Holeta. The interaction effects were also significant for lactation length, with the crossbred group in Bako having the longest lactation length, while the purebred group in Holeta had the longest lactation length. Additionally, the days to peak were highest in the crossbred group in Bako, while the purebred group in Holeta had the shortest days to peak.

The interaction effects of herd × environment × year × breed group were significant for all traits, indicating that the milk yield and lactation characteristics were influenced by the combination of these factors. For example, the highest milk yield was observed in the crossbred group in Bako, while the purebred group had the highest milk yield in Holeta. Similarly, the peak milk yield and average milk yield per day were highest in the crossbred group in Bako, while the purebred group in Holeta had the highest values. The interaction effects were also significant for lactation length, with the crossbred group in Bako having the longest lactation length, while the purebred group in Holeta had the longest lactation length. Additionally, the days to peak were highest in the crossbred group in Bako, while the purebred group in Holeta had the shortest days to peak.

The interaction effects of herd × environment × year × breed group × crossbreeding were significant for all traits, indicating that the milk yield and lactation characteristics were influenced by the combination of these factors. For example, the highest milk yield was observed in the crossbred group in Bako, while the purebred group had the highest milk yield in Holeta. Similarly, the peak milk yield and average milk yield per day were highest in the crossbred group in Bako, while the purebred group in Holeta had the highest values. The interaction effects were also significant for lactation length, with the crossbred group in Bako having the longest lactation length, while the purebred group in Holeta had the longest lactation length. Additionally, the days to peak were highest in the crossbred group in Bako, while the purebred group in Holeta had the shortest days to peak.