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# Adaptability Study of Released Midland Maize Varieties at Midland of Guji Zone, Southern Ethiopia

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**ABSRACT:** *Lack of improved maize variety is highly limited in different parts of Ethiopia due to inaccessibility of different production factors. Guji Zone is one of such areas where the technologies are not widely addressed and adopted so far. This study was conducted by Bore agricultural research center with the objective of selecting and recommending adaptable high yielding and early maturing maize varieties for mid land agro-ecologies of Guji zone. The experiment was done at three locations Adola on station and two farmer's field (Dole and Kiltu Sorsa). Six (6) released maize varieties with one local check were used. RCBD experimental design with three (3) replications was used on plot size of 5mx6m. All phonological and yield data were collected subjected to analysis using GenStat (18$^{th}$ edition) software. Combined data analysis was used to test the performance of the varieties across the testing locations. The result of the study shows that, all varieties revealed significant difference for the selected characters across the locations. Based on the obtained result, two Maize varieties (MH-140 and BH-546) were early maturing and gave higher yield .Therefore; these varieties were selected and recommended for the study area and similar agro-ecologies of Guji Zone.*

**KEYWORDS:** adaptability, midland maize, varieties, guji zone, Southern Ethiopia

## INTRODUCTION

Maize is one of the most important field crops in terms of area coverage, production, and economic importance in Ethiopia. It grows from sea level to over 2,600 m.a.s.l. from moisture deficit semi-arid lowlands, mid-altitude and Highlands to moisture surplus areas in the humid lowlands, mid-altitudes and highlands. Of these ecologies, the mid- and low-altitude sub humid maize agro-ecologies are well known for maize cultivation in Ethiopia. The mid-altitude is mainly located in western, southern, eastern and central regions while the low altitude is found in the south eastern parts of the country. The weather conditions characterized by warm temperatures and sufficient volumes of rainfall coupled with the relatively fertile soils of these regions creates favorable conditions for maize cultivation.

In Ethiopia cereals account for about 80% of the annual crop production and maize is the first in total production and yield per unit area and second in area coverage among all the cereals. Total area covered by maize during the 2015/16 growing season was 2.1 million ha and the national average yield was about 33.87 q ha$^{-1}$ (CSA, 2016). Maize improvement in Ethiopia started half a century ago. During the late1960s and early 1970s, several promising hybrids and composite varieties of East African origin were introduced and evaluated at different locations.

These resulted in the recommendation of several maize varieties for the maize growing regions of the country (Abdurahman, 2009). Crops like tef, maize, wheat, barley, sorghum, finger millet and oats/'aja' with regional productivity (q/ha) of 11.18, 23.45, 18.65, 17.74, 16.26, 11.23, 9.56, respectively are cereals grown in different agro-ecologies of southern region (CSA, 2009). From this regional productivity list, it can be realized that the productivity of all crops is too low which is less than half of the potential productivity which could be obtained through using improved production technologies. The survey report which conducted at zonal level jointly by Bore Agricultural Research center (BOARC) and zone Bureau of Agriculture in 2008, also confirmed that the yield obtained from the local cultivars is too low (30.21q/ha). And in many parts of the zone, lack of improved crops varieties and associated improved management and protection practices are some of the major constraints in the crop production systems; i.e. farmers in many remote areas of the zone even do not know the existence of the new crop varieties. To resolve specific agricultural productivity constraints in the zone, several works have been done at zonal level. Massive movement to test suitability of the existing technologies on different cereal crops such as maize, bread wheat, tef and food barley has been carried out in different agro-ecologies and the best technologies were pre-scaled up in some localities of the zone. Even though only few localities were reached with limited number of technologies in the last two years, an appreciable improvement in crop productivity was realized in the target areas. To advance improvement of crop productivity in different localities, continual identification of the best and suitable crop technologies appeared to be essential. This can be achieved, through adaptability tests and generation of new technologies. Keeping this in view, the study was conducted at Adola subite and on farm kebeles of Adola district to compare the performance of hybrid, open pollinated and commercial varieties for their adaptability and stability with the following objectives:-

- To evaluate the adaptability and performance of the improved varieties released for mid-altitude
- To identify and select the best performing variety/ies for the target area

# MATERIALS AND METHODS

**Experimental Site**

Adola district belongs to the agro-ecological classification of hot to warm sub-moist mid-lands. The district is divided into 48 PAs; it has an average altitude of 1600 m.a.s.l. The major crops produced in the area are maize, teff, wheat from cereals, haricot bean, from pulses and cash crops such as coffee and chat. The farming calendar for these major crops varied depending on the season. In the main season ''Belg'' which has long rain fall start from March/April, the land preparation starts from December. Major crops produced during this season are Maize and horticultural crops. The second season ''Mihere'' receive rain fall from September and last 2$^{nd}$ weeks of November. Major crops produced during this season are Teff and wheat in large. The predominant form of crop production in the study area is rain-fed. The productivity of farmland is influenced by the lack/unavailability of improved technologies and other production factors.

**Experimental Materials and Design**

The experiment was conducted by using seven released midland maize hybrid varieties which was obtained from Bako Agricultural research center. Randomized complete block design with three replications was used to conduct the experiments per site. The Seeds was planted in rows with two seeds per hill at a rate of 25kg/ha in a plot consisting of six rows each of 6m long and 5m wide and seedlings will be thinned into one plant per hill four weeks after emergence to obtain 144 plants per plot. The inter row spacing was 0.75m, while the intra row spacing was 0.25m, giving population density of 53,333 plants per hectare. Fertilizers was applied at the rate of 100/100 kg/ha DAP/Urea. Urea was applied in split (half at planting and the other half at knee height). First weed control was carried out after three weeks of planting and next weeding as needed.

**DATA COLLECTED**

The middle four rows were used for data collection and harvest at maturity. Individual plant base data as well as plot base data was collect on seven traits of maize varieties. Data was collected on individual plant basis from five randomly selected plants such as : plant height (cm), Ear length (cm), ears per plant, tassel length (cm) and cob weight (gm) while data on plot basis included grain yield (qt/ha).

# RESULTS AND DISCUSSION

## Phenological and Growth Parameters

### Days to Thasseling

The analysis of variance revealed that the main effect of variety was significant ($P < 0.05$) effect on days to thasseling while the main effect of location highly significantly affect days to thasseling of maize. But the two-factor interactions of variety x location did not influenced days to thasseling. The highest prolonged duration to thassel (87.89days) was observed in the local check. However, the minimum duration (84.67days) to thasseling was recorded at variety SPRH, as it was not statistically different from the BH-546 variety (Table 2). This may be due to genetic variations among different maize varieties. In line with this result, Abduselam *et al. (2017*) reported significant difference among maize varieties. Similarly, Hussain *et al.* (2011) reported differential pattern of maize varieties for days to thassel. Other researchers also reported genetic variations among different maize hybrids (Ihsan *et al*., 2005; Haq *et al*., 2005).

### Days to Silking

The analysis of variance revealed that the main effect of variety and location was significant ($P < 0.05$) on days to Silking of maize while the two-factor interactions of variety x location did not influenced days to maturity.

The highest prolonged duration to silking (90days) was observed in the local check while the minimum duration to silking (85.33days) was recorded at variety MH-140 as it was not statistically different from the BH-546 variety (Table 2). This may be due to genetic variations among different maize varieties. In line with this result, Abduselam *et al. (2017*) reported significant difference among maize varieties.

### Days to Maturity

The analysis of variance revealed that the main effect of variety was highly significantly ($P<0.01$) affect days to maturity while the main effect of location significantly ($P < 0.05$) affect days to maturity of maize. But the two-factor interactions of variety x location did not influenced days to maturity.

The highest prolonged duration to mature (153day) was observed in the BH-546 as it was not statistically different from the SBRH, MH-140 and local check varieties while the minimum duration to maturity (146.7day) was recorded at variety SPRH (Table 2). But, Hailegabriel *et al.* (*2016*) reported lower days to maturity (143.22 and 142.56 days) for MH-140 and BH-546 varieties. This variation may be due to difference in experimental locations.

**Plant height**

The analysis of variance revealed that the main effect of variety was significantly (P < 0.05) affect plant height of maize while the main effect of location and the two-factor interactions of variety x location did not influenced days to maturity. The highest plant height was observed in the variety SPRH (246.3cm) as while the minimum plant height (215.4cm) was recorded at variety MELKASA-2 (Table 3). This might be due to the reason that most hybrid varieties have desirable traits for lodging and most of them are dwarf. Similarly Hailegabriel *et al.* (*2016*) reported 227.7 and 238.5 cm plant height for MH-140 and BH-546 varieties respectively. Abduselam *et al.* (*2017*) also reported different plant height for different maize varieties.

**Number of Leaf/plant**

The analysis of variance revealed that the two-factor interactions of variety x location was highly significant (P < 0.01) on number of leaf per plant of maize while the main effect of variety and location did not influenced number of leaf per plant. The highest number of leaf per plant (21.08) was observed in the interaction of variety BH-546 and Kiltu Sorsa location while the minimum number of leaf per plant (13.33) was recorded at interaction of variety SBRH and Dole location (Table 1). This might be due to interaction effect of genetic and environment (G x E).

**Table 1. Combined Mean of number of leaf/ plant of Maize at Adola, 2017**

| Genotype | Location | | |
|---|---|---|---|
| | **Kiltu Sorsa** | **Dole** | **Onsite** |
| SBRH | 17.48$^{b-e}$ | 13.33$^{k}$ | 15.21$^{f-j}$ |
| BH-546 | 21.08$^{a}$ | 14.96$^{h-k}$ | 16.08$^{d-h}$ |
| MH-140 | 18.73$^{b}$ | 13.88$^{ijk}$ | 15.79$^{e-h}$ |
| Local check | 15.65$^{f-i}$ | 15.13$^{g-k}$ | 16.96$^{b-f}$ |
| MELKASA-2 | 18.07$^{bc}$ | 13.5$^{jk}$ | 16.21$^{d-h}$ |
| BHQPM-548 | 16.23$^{d-h}$ | 14.88$^{h-k}$ | 16.79$^{c-g}$ |
| SPRH | 15.58$^{f-i}$ | 16.29$^{c-h}$ | 17.79$^{bcd}$ |
| LSD(0.05) | 1.798 | | |
| CV (%) | 6.7 | | |

**Yield and Yield Component Parameters**

**Ear length**

The analysis of variance revealed that the main effect of location significantly (P < 0.05) affect ear length while the two factors interaction and main effect of variety did not significantly (P < 0.05) effect ear length of maize. The longest ear length (17.5cm) was recorded at Dole location where as the shortest ear (15.01cm) obtained at Kiltu Sorsa as it was statistically at par with Adola on station. Similar with this result, Hailegabriel *et al. (2016*) reported significant effect of environment on maize varieties and no significant effect of G x E.

**Cob weight**

The analysis of variance revealed that the main effect of variety and location were significantly (P < 0.05) affect cob weight of maize while the two-factor interactions of variety x location did not influence cob weight. The highest cob weight was (275.6g) observed in the variety SBRH which was statistically not different from MH-140 and BH-46 while the minimum cob weight (179.1g) was recorded at variety SPRH (Table 2). This may be due to genetic and environmental variability among maize varieties.

**Number of ear per plant**

The analysis of variance revealed that the main effect of variety and location is not significantly (P < 0.05) effect on Number of ear per plant of maize as well as the two-factor interactions (Table 2). This finding in line with Kandil *et al (2017*) who reported no significant difference among maize varieties, eason and there interaction.

**Number of row per cob**

The analysis of variance revealed that the main effect of variety is highly significantly (P < 0.01) affect Number of row per cob of maize while the main effect of location and the two-factor interactions of variety x location did not influenced Number of row per cob. The highest Number of row per cob (15.06) was observed in the variety SBRH even though it was statistically at par with variety BH-546 while the minimum Number of row per cob (12.92) was recorded at variety SPRH (Table 2). This might be due to genetic variability among maize varieties and this may related to yield. In line with this result, Taye *et al*. (2016) who reported different number of row per for different maze varieties.

**Number of seed per cob**

The analysis of variance revealed that the main effect of variety was significant (P < 0.05) on Number of seed per cob of maize while the main effect of location and the two-factor interactions of variety x location did not influenced Number of seed per cob.

The highest Number of seed per cob (570.4) was observed in the variety BH-546 while the minimum Number of seed per cob (452) was recorded at local check which is statistically at par with variety SPRH, MELKASA-2 and BHQPM-548 (Table 2). This might be due to genetic variability among maize varieties. Similar to this result,

## Grain yield

The analysis of variance revealed that the main effect of variety was significantly (P < 0.05) affect grain yield of maize while the main effect of location and the two-factor interactions of variety x location did not influenced grain yield. The highest grain yield (4667kg/ha) was obtained in the variety MH-140 which was not statistically different from BH-546 variety while the minimum (3515kg/ha) grain yield was recorded at variety BHQPM-548 (Table 2). This might be due to genetic variability among maize varieties. Similar with this result, Hailegabriel *et al. (2016*) reported interaction effect of G x E and main effects of variety and environment on yield of maize. But the yield they record for variety MH-140 and BH-546 were

| Genotype | CW | DTM | DTS | DTTH | EL | GY (kg/ha) | NEPP | NRPC | NSPC | PH | TKW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SBRH** | 275.6$^{a}$ | 151.9$^{a}$ | 88.67$^{a}$ | 86.67$^{ab}$ | 15.72 | 3920$^{bc}$ | 0.96 | 15.06$^{a}$ | 493.3$^{b}$ | 245.4ab | 285.8$^{b}$ |
| **BH-546** | 269.1$^{a}$ | 153$^{a}$ | 86$^{bc}$ | 84.67$^{c}$ | 18.06 | 4656$^{a}$ | 1 | 14.72$^{a}$ | 570.4$^{a}$ | 236.7ab | 251.4$^{cd}$ |
| **MH-140** | 266.4$^{a}$ | 152.6$^{a}$ | 85.33$^{c}$ | 85.33$^{bc}$ | 15.81 | 4667$^{a}$ | 1 | 14.44$^{ab}$ | 461.7$^{b}$ | 244ab | 326.5$^{a}$ |
| **Local check** | 206.1$^{b}$ | 152.6$^{a}$ | 90$^{a}$ | 87.89$^{a}$ | 15.68 | 4586$^{a}$ | 1 | 13.36$^{c}$ | 452$^{b}$ | 233.4ab | 274.6$^{bc}$ |
| **MELKASA-2** | 202.8$^{b}$ | 148.9$^{b}$ | 86.89$^{b}$ | 85.44$^{bc}$ | 15.15 | 4086$^{abc}$ | 1 | 13.69$^{bc}$ | 487.7$^{b}$ | 215.4c | 253.5$^{bcd}$ |
| **BHQPM-548** | 194.8$^{b}$ | 149.3$^{b}$ | 88.78$^{a}$ | 86.89$^{a}$ | 16.14 | 3515$^{c}$ | 1 | 14.5$^{ab}$ | 510.1$^{b}$ | 231.2b | 241.2$^{d}$ |
| **SPRH** | 179.1$^{b}$ | 146.7$^{c}$ | 86.$^{56\ bc}$ | 84.67$^{c}$ | 16.11 | 4219$^{ab}$ | 1 | 12.92$^{c}$ | 453.1$^{b}$ | 246.3a | 233.5$^{d}$ |
| **LSD(0.05)** | 80.73 | 2.63 | 3.56 | 2.36 | NS | 607.05 | NS | 0.84 | 59.68 | 14.51 | 32.53 |
| **Location** | | | | | | | | | | | |
| **Kiltu Sorsa** | 248.5$^{a}$ | 151.1$^{a}$ | 83.05$^{c}$ | 88.43$^{a}$ | 15.01$^{b}$ | 4236 | 1 | 13.90 | 513.57 | 238.96 | 273.77 |
| **Dole** | 234.5$^{a}$ | 149.2$^{b}$ | 89.14$^{b}$ | 84.52$^{b}$ | 17.5$^{a}$ | 4405 | 1 | 14.17 | 487.88 | 235.12 | 267.87 |
| **Adola On Site** | 200$^{b}$ | 151.8$^{a}$ | 90.19$^{a}$ | 84.86$^{b}$ | 15.77$^{b}$ | 4065 | 0.98 | 14.23 | 467.83 | 234.05 | 258.3 |
| **LSD(0.05)** | 80.73 | 2.63 | 2.58 | 2.36 | 3.53 | NS | NS | NS | NS | NS | NS |
| **CV (%)** | 21.5 | 1.1 | 4.3 | 1.7 | 13.3 | 17.3 | 4.8 | 6.2 | 12.8 | 6.5 | 12.8 |

greater than this finding. This might be due to environmental variation and shortage of rain fall during experimental season. Similar result was reported by Taye *et al*. (2016) and Abduselam *et al. (2017*) who evaluated and identified high yielding maize varieties among different genotypes tested.

**Table 2. Combined Mean of CW, DTM, DTS, DTTH, EL, GY, NEPP, PH, TKW, NRPP, NSPC, PH & TKW of Maize at Adola, 2017**

**Key:** CW: cob weight, DTM: date to maturity, DTS: date to ilking, DTTH: date to thassel, EL: ear length, GY: grain yield, NEPP: number of ear per plant, PH: plant height, TKW: thousand kernels weight, NRPC: number of row per cob, NSPC: number of seed per cob

## Thousand Kernel weight

The analysis of variance revealed that the main effect of variety was highly significantly ($P < 0.01$) affect thousand kernel weight of maize while main effect of location and the two-factor interactions of variety x location did not influenced thousand kernel weight. The highest thousand kernel weight (326.5g) was observed in the variety MH-140 while the minimum thousand kernel weight (233.5g) was recorded at variety SPRH (Table 3). The differences in the thousand kernels weight of the maize varieties could be attributed to genetic differences. This result is similar with Taye *et al*. (2016) and Hailegabriel *et al. (2016*) who evaluated and reported different thousand kernels weight of maize varieties among different genotypes tested.

**Table 3. Combined Mean of PH and TKW of Maize at Adola, 2017**

| Genotypes | PH | TKW |
|---|---|---|
| SBRH | 245.4ab | 285.8b |
| BH-546 | 236.7ab | 251.4cd |
| MH-140 | 244ab | 326.5a |
| Local check | 233.4ab | 274.6bc |
| MELKASA-2 | 215.4c | 253.5bcd |
| BHQPM-548 | 231.2b | 241.2d |
| SPRH | 246.3a | 233.5d |
| LSD(0.05) | 14.51 | 32.53 |
| Location | | |
| KS | 238.96 | 273.77 |
| DL | 235.12 | 267.87 |
| OS | 234.05 | 258.3 |
| LSD(0.05) | NS | NS |
| CV (%) | 6.5 | 12.8 |

## CONCLUSION AND RECOMMENDATION

Analysis of the results revealed that days to maturity, date silking, date to thasseling and cob weight were significantly affected by both main effects of variety and location where as number of row per cob, grain yield, number of seed per cob, plant height, and thousand kernels weight were only affected by main effect of variety. Similarly ear length was affect only by the main effect of location while number of leaf per plant was affected by the two factors interaction.
From the tested varieties, MH-140 showed better performance for the evaluated characters and gave highest yield (4667kg/ha) followed by BH-546 (4656kg/ha). Therefore, as grain yield is an important parameter to select these varieties, MH-140 and BH-546 varieties were recommended for study areas and similar agro ecologies among the tested varieties.

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