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Performance Evaluation of Highland Maize (*Zea Mays L.*) Varieties at Highland Area of South Omo Zone, Southern Ethiopia

Research Article

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Temesgen Jerjero[1]* and Wondimu Adila[2]

Department of plant breeding, Southern Agricultural Research Institute, Jinka Agricultural Research Center, Ethiopia

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***Corresponding author:** Temesgen Jerjero, Department of plant breeding, Southern Agricultural Research Institute, Jinka Agricultural Research Center, Ethiopia

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Abstract

In South Omo Zone, there are several maize production constraints, among which shortage of high yielder variety and stable improved high land maize variety is the major constraint. The objective of this study was to evaluate and recommend high yield performance of improved high land maize variety for grain yield trait. The study was conducted at highland location for two consecutive years, during 2021/22 and 2022/23 in main cropping season. The trial was laid in RCBD with three replications. The varieties were (Jibat, Wenchi and Koleba) and one local check was evaluated. Data collected on, days to maturity, plant height (cm), number of ear plant-1, ear height (cm) ear length (cm), grain yield (kg) and hundred seed weight (g) were recorded. The varieties were planted in rows with 3 m width and 4m length (12m2) along four rows per plot, 75cm between rows and 25cm between plants. Combined mean squares for the treatments were significant (P< 0.05) for Days to maturity, plant height, ear height and grain yield. However, there were none significant difference (P>0.05) for ear length, cob length, number of ear per plant and hundred seed weight. From the evaluated varieties, the maximum combined mean grain yield was recorded to variety Gibate (6679.35kg ha-1) and the minimum grain yield was recorded to local variety (2272.32 kg ha-1). It could be concluded that, variety Gibate (6679.35kg ha-1) can be demonstrated and popularized to the target area and similar agro-ecologies.

Keywords

Grain yield; Gibate; Maize; Performance; Variety

Introduction

Maize (Zea Mays L) is one of the most important cereals broadly adapted worldwide [1]. In Ethiopia maize is produced for food, especially, in major maize producing regions mainly for low-income groups, it is also used as staple food. Maize is consumed as ''Injera,'' Porridge, Bread and ''Nefro.'' It is also consumed roasted or boiled as vegetables at green stage. In addition to the above, it is used to prepare ''Tella'' and ''Arekie.'' The leaf and stalk are used for animal feed and dried stalk & cob are used for fuel. It is also used as industrial raw material for oil & glucose production [2]. In Ethiopia, it is grown in the lowlands, the mid-altitudes and the highland regions. It is an important field crop in terms of area coverage, production and utilization for food and feed purposes. However, maize varieties mostly grown in the highlands at an altitude ranging from 1,700 to 2,400 masl of Ethiopia

are local cultivars with poor agronomic practices (Beyene et al., 2005[3]. In Ethiopia, its total annual production and productivity exceeds all other cereals (23.24% of 13.7 Million tons), and second after tef (*Eragrostis tef*) in area coverage (16.12% of the 8.7 000 000 ha), maize is one of the most important crops grown in Ethiopia [4]. It is the most extensively cultivated food crops and main source of calorie in western, southern and eastern part of Ethiopian [5]. With the introduction of the hybrid seeds and the high yielding open pollinated varieties, and the increasing local demand, the importance of the crop may increase even further [4]. Considering its importance in terms of wide adaptation, total production and productivity, maize has been selected as one of the high priority crops to feed the increasing population of Ethiopia. Past research efforts in Ethiopia resulted in the development and release of open-pollinated and hybrid varieties for different agro-ecologies of the country [4]. Maize holds a unique exceptional position in world agriculture as food; feed for livestock and as a source of diverse, industrially important essential products. Maize grains have great nutritional value as they contain 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3.0% sugar and 1.7% ash. It is also used for manufacturing starch, corn flakes alcohol, salad oil, soap, varnishes, paints, printing and similar products [6]. Maize is one of the most important cereal crops in midland areas of the southern region in general and in highland areas of the South Omo Zonal administration in particular. Its production is common in highland areas of South Omo Zone, especially in Debub Ari district [7]. Even though the crop is important in the target area, some factors constrained the productivity of maize in the target areas. Advancing the improvement of crop productivity in different localities can be achieved, through testing the adaptability of crop technologies. Keeping this in view; the present study was conducted to evaluate and recommend the performance of recently released improved highland maize varieties for their adaptability in the target area.

Materials and Methods

Description of the study area

The experiment was conducted at Geder kebele in Debub Ari District during the main cropping seasons from 2021/22 to 2022/23 under rain fed condition. The study site is located at an altitude of 2206 meters above sea level (masl) with geographical coordinates of longitude 036°38'44'' E' and Latitude 05°53' 22.422" N. The study site has a bi-modal rainfall pattern with the shorter rainy season from March-May and the longest rainy season from August through November. The total annual rainfall is 1852.2 250.7 mm. The annual mean minimum and maximum temperatures are 15.5±0.9°C and 18.7 ±1.4°C, respectively.

Treatments and experimental design

Three improved highland maize varieties (Jibat, Wenchi, Koleba) with one local check were arranged in a randomized complete block design (RCBD) with three replications. All plots were fertilized uniformly at the rate of 100 kg ha^{-1} urea and 100 kg ha^{-1} NPS. All NPS and half of urea at planting and the remaining half urea at silking were applied. The experimental plot had an area of 4m x 5m (20 m^2) separated by a distance of 1m between plots within a block and 1.5 m between blocks within the experiment. Spacing of 75 cm b/n rows and 25 cm b/n plants was maintained and seed rate of 25 kg ha^{-1} was used. Any other important agronomic practices were applied equally to all the entries at their proper time of application.

Data collection

The following yield and yield related traits such as days to maturity, plant height, ear height, ear length, number of ears/plant, cob length,100 seed weight(g) and grain were collected.

Table 1: Mean performance of yield and yield component of highland maize at Debue Ari District of South Omo Zone, Southern Ethiopia, during 2021 /22 Cropping Season

Trt	DM	PH(cm)	EH(cm)	EL(cm)	E/P	CL(cm)	YD(kg/ha)	HSW(g)
Jibate	193.75^{b}	210.20^{a}	83.80^{b}	26.50	1.6000	19.250	6806.0^{a}	22.375
Koleba	200.0^{b}	190.00^{ab}	67.80^{c}	30.0	1.8000	19.100	5509.5^{b}	21.625
Wenchi	188.75^{b}	170.25^{b}	59.65^{c}	27.450	1.1000	19.450	4815.9^{ab}	20.00
Local	214.5^{a}	208.75^{a}	102.85^{a}	27.250	1.9500	21.250	2311.1^{c}	20.500
CV (%)	4.42	8.27	9.17	5.41	4.06	4.91	10.31	10.25
LSD (5%)	14.077	25.774	11.516	Ns	NS	Ns	1163.9	Ns

Note: Means with the same letters within the columns are not significantly different at p<0.05. Trt: Treatments; DM: Days to Maturity; PH: Plant Height; EH: Ear Height; EL: Ear Length; E/P: Number of Ears per Plant; GY: Grain Yield; HSW: Hundred Seed Weight; NS: None Significance

Table 2: Mean performance of yield and yield component of highland maize at Debue Ari District of South Omo Zone, Southern Ethiopia, during 2022/23 Cropping Season

Tret	DM	PH(cm)	EH(cm)	EL(cm)	E/P	CL(cm)	YD(kg/ha)	HSW(g)
Jibate	188.75^{c}	155.00	56.75	20.00	1.10	16.25	70138a	27.37
Koleba	206.25^{b}	150.25	49.50	20.25	1.00	15.0	4105bc	28.25
Wenchi	170.00^{c}	148.25	42.50	20.50	1.025	16.75	4558b	27.50
Local	213.00^{a}	42.25	51.50	19.00	1.00	14.0	2697c	27.00
CV (%)	1.61	5.93	4.66	12.24	6.29	12.72	9.72	5.36
LSD (5%)	5.01	ns	Ns	ns	ns	ns	1449.0	Ns

Note: Means with the same letters within the columns are not significantly different at p<0.05. DM: Days to Maturity; PH: Plant Height; EH: Ear Height; EL: Ear Length; E/P: Number of Ears per Plant; GY: Grain Yield; HSW: Hundred Seed Weight; NS: None Significance

Data analysis

The collected data were subjected to analysis of variance in randomized complete block design (RCBD) using SAS software version 9.2 (SAS, 2008)[8] with a generalized linear model (GLM) procedure. Means were separated using least significant differences (LSD) test at 5% level of significance. Homogeneity of error mean square between the two years was tested by the F-test on variance ratio Table 1,2.

Results and Discussion

Combined Analysis of Variance of Yield and Yield Related Trait

The combined analysis of variance was done after homogeneity test for yield and yield related traits for years. The combined analysis of variance for treatments showed significant differences for days to maturity, plant height, ear height and grain yield and there were none significant (P>0.05) differences for ear length, cob length, number of ear per plant and hundred seed weight Table 3. The significance difference among varieties indicates that the presence of variability for grain yield among the tested entries. This result is in agreement with the previous findings reported by [9]. This result is in agreement with the previous findings reported by [10] which states maize varieties had significantly different (P<0.05) in grain yield and some agronomic characters. Similar results were reported by [6,11] who evaluated and identified high yielding maize varieties among different genotypes tested. This also agrees with the findings of [12] who reported that variations in growth and yield of maize due to climatic factors.

Combined mean performance of growth, yield and yield related trait

Days to maturity (90%): All varieties showed significant difference for days to maturity Table 4. Among the tested varieties, Wenchi (179.38 days) matures early than the other varieties while local variety had late maturing (213.75days).

Plant height (cm): All varieties showed significant difference for plant height Table 4. Among the tested varieties, Gibate had the longest plant height ((182.6 cm)) followed by variety Wenchi (159.25cm) had shortest plant height respectively. [12] reported differential pattern of

Table 3: Mean square values of traits of highland maize varieties over years during 2021/22 and 2022/23

SV	DF	DM	PH	EH	EL	E/P	CL	GY	HSW
Rep	3	56.25^{ns}	401.5^{ns}	359.72^{ns}	1.435^{ns}	0.0412^{ns}	2.998^{ns}	6099854^{ns}	13.53^{ns}
Trt	3	1764.58*	775.0*	1088.77*	6.735^{ns}	0.27458^{ns}	1.525^{ns}	1.319*	2.63^{ns}
Year	1	180.50^{ns}	16827.0*	6480.91*	494.551*	3.00125*	145.351*	3.096^{ns}	328.32*
Trt*Yr	3	218.42*	746.6*	504.72*	4.268^{ns}	0.27458*	8.658^{ns}	4072485^{ns}	3.09^{ns}
Mean square of Errors (MES)									
Year -1	-	7.444	59.63	51.83	2.25778	4.05139	2.94250	2937556	18.3056
Year -2	-	9.83	77.896	152.396	5.95139	6.752	3.88889	820561	17.8767
F=max	-	1.32^{ns}	1.31^{ns}	2.94^{ns}	2.3^{ns}	1.67^{ns}	1.32^{ns}	0.28^{ns}	1.02^{ns}

Note:* NS: None Significance; SV: Source of Variation; Rep: Replication; Trt: Treatment; Yr: Year; DM: Days to Maturity; PH: Plant Height; EH: Ear Height; EL: Ear Length; E/P: Number of Ears per Plant; GY: Grain Yield; HSW: Hundred Seed Weight; NS: None Significance

Table 4: Combined Mean Performance of highland Maize of 2021/22 and 2022/23 Cropping Season

Trt	DM	PH(cm)	EH(cm)	EL(cm)	E/P	CL(cm)	YD(kg/ha)	HSW(g)
Jibate	191.25^{c}	182.6^{a}	70.27^{a}	23.25	1.30^{b}	1.30^{b}	6679.35^{a}	23.93
Koleba	203.13^{b}	170.13^{b}	58.65^{b}	25.12	1.40^{ab}	1.40^{ab}	4884.75^{b}	24.93
Wenchi	179.38^{d}	159.25^{c}	51.07^{b}	23.97	1.05^{c}	1.05^{c}	4441.14^{c}	23.75
Local	213.75^{a} A	168.50^{a}	77.17^{d}	23.12	1.47^{a}	1.47^{a}	2272.32^{d}	24.68
CV (%)	3.64	8.30	5.89	9.61	2.79	9.66	5.68	6.40
LSD 0.05	7.46	14.83	10.62	Ns	0.17	1.77	1220.28	Ns

Note: Means with the same letters within the columns are not significantly different at p<0.05. DM: Days to Maturity; PH: Plant Height; EH: Ear Height; EL: Ear Length; E/P: Number of Ears per Plant; GY: Grain Yield; HSW: Hundred Seed Weight; NS: None Significance

maize varieties for plant height and [5] reported that, all genotypes showed significant difference for plant height.

Ear height (cm): The variations in ear height (cm) in present investigations were found to be significant due to divergent maize varieties. The local check had tallest ear height (77.17cm), while the shortest ear height was recorded to Wenchi (51.07 cm). These results get sufficient validation from the findings of [13].

Ear length (cm): The variations in ear height (cm) in present investigations were found to be none significant different. Wenchi variety had maximum ear length (23.97cm), while the shortest ear length was recorded to local variety (23.12cm).

Cob length (cm): The variations in ear height (cm) in present investigations were found to be none significant different. Local variety had longest cob length (1.47cm), while the shortest cob length was recorded to Gibate variety (1.30 cm).

Number of ears per plant: None significant differences were recorded among the maize varieties tested for number of ears per plant Table 4. Local variety produced maximum number of ears per plant (1.47), while that of variety Wenchi produced minimum number of ears per plant (1.05). Similar results was reported by [14] who states, there were genetic variations among different maize varieties.

Grain yield (kg ha-1): Data pertaining to grain yield are shown in Table 4. Significant differences were revealed for grain yield among different varieties used in this study. The significant differences among varieties indicate the presence of variability for grain yield. This finding is in agreement with the reports of [15] who indicated that there were significant differences observed among the maize varieties for grain yield. Variety Gibate showed higher grain yield (6679.35kg ha-1), while the local variety produced lower grain yield (2272.32d kgha-1). Similar result were reported by [16] who evaluated and identified high yielding highland maize varieties tested and [17] also evaluated and identified high yielding maize varieties among different genotypes tested.

Hundred seed weight (g): Grain weight is an important yield parameter and is vary from variety to variety. Data pertaining 100-seed weight (g) Table 4 were none significantly different. Maximum value for 100- seed weight was shown by local variety (24.93g), while the minimum value was recorded to variety Wenchi (23.75g). The possible reason for the observed differences for all the traits recorded could be because of variation in the genetic makeup of the studied varieties. In support of this finding, different researchers have reported significant amount of variability in different maize populations studied. [18] Observed considerable genotypic variability among various maize genotypes for different traits. Significant genetic differences for morphological parameter for maize genotypes were also reported by [14].

Conclusion

From this experiment, it is concluded that the variety from the evaluated varieties, Jibat remained superior in its yield and yield component during the experimental years. Therefore, this variety is recommended and popularized for highland areas of South Omo Zone and for other similar agro-ecologies.

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