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Performance Evaluation and Adaptability of Improved Released Maize (*Zea mays* L.) Varieties in the Midlands of Fedis District of Eastern Hararghe

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ABSTRACT

Nine released maize varieties with one local check were tested at two sites in randomized complete block design with three replication during 2014/2015 cropping season. The experiment was carried out to test the adaptability of improved mid-altitude maize varieties and identify and select the best high yielding variety/ies for the target area. The treatments consisted of three OPV maize varieties (Gibe-1, Gibe-2 and Raaree-1) and six Hybrid maize varieties (Hora, Jibat, QPM, Argane, kuleni, Wanchi) and one local check were evaluated at two locations. All the varieties were planted with inter row spacing was 0.75 m and intra row spacing of 0.25 m. Urea and DAP were used as a source of N and P at recommended rate of application. The analysis of variance revealed significant (P<0.05) differences in the parameters studied of maize varieties at both location. Significantly hybrid maize variety Argane gave highest grain yield than local and other tested varieties at both locations. These results depicted that across location variety Argane was significantly higher grain yield advantage by about 16.6% over local check followed by QPM over location. Therefore, these varieties are recommended to demonstrate with production packages in midlands of Fedis districts and similar agro ecologies.

Keywords: Maize, Adaptability, Variety

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereals broadly adapted worldwide [1]. It is largely produced in Western, Central, Southern and Eastern parts of Ethiopia. In 2014/2015, cropping season 2,114,876.10 hectares of land was covered with maize with an estimated production not less than 72,349,551.02 quintals [2]. In Ethiopia, maize (*Zea mays* L.) is one of the major cereal crops grown for its food and feed values. It is one of the most important staple food and cash crops providing calories for the consumers and income for the traders.

It grows from sea level to over 2,600 mas from moisture deficit semi-arid lowlands, mid-altitude and highlands to moisture surplus areas in the humid lowlands, mid-altitudes and highlands. The mid-altitude is mainly located in western, southern, eastern and central regions while the low altitude is found in the south western parts of the country.

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. 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 [3]. It is the most extensively cultivated food crops and main source of calorie in western, southern and eastern part of Ethiopian [4]. 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 [3].

The popularity of maize in Ethiopia is partly because of its high value as a food crop as well as the growing demand for the Stover as animal fodder and source of fuel for rural families [5]. Although, productivity of maize in Ethiopia is showing increment in recent years however productivity of eastern harerghe is still low 24.06 quintal/ha compared to the national and regional average of Oromia 32.54 and 33.19 quintal/ha respectively [6].

In maize farming system of Eastern Ethiopia, especially Eastern Hararghe farmers traditionally use local variety of

maize, for production and productivity for a long period of time. Lack of insufficient knowledge and awareness of farmers on the production and benefits of these new and early maturing varieties with good agronomic practice and potential yield is a leading constraint. Adaptability and stability are interchangeably used. Identification of adaptable variety minimizes the magnitude of scale or rank shift of their performance across or specific environment [7-9]. Hence, it is important to adapt these medium to early maturing maize varieties to the study area. Thus, the present study was conducted to compare the performance of commercial varieties for their adaptability and to recommend a suitable one for the local maize growers of eastern hararghe of Ethiopia and similar agro-ecologies.

MATERIAL AND METHODS

Description of the experimental site

The experiment was conducted on two locations at Dabine and Umerkule PA of Fedis district of eastern Hararghe Zone of Oromia region. Fedis district has latitude between 8°22' and 9°14' North and longitude between 42°02' and 42°19' East, in middle and low land areas: altitude range is from 1200-1600 m. a. s. l, with a prevalence of low lands. The district receives average annual rain fall of 400-804 mm; the minimum and maximum air temperature of 20-25°C and 30-35°C, respectively [10]. As in the most of the Horn of Africa, two rainy seasons characterize Fedis woreda's climate. The first named 'Belg'is the shortest one and takes place between March and May while the second and the most important is 'Meher' between July and October. The rainfall distribution during the year is bi-modal, with a dry-spell period during the months of June and July which, depending on its duration, may affect crop growth.

Experimental materials and design

An experiment was conducted in 2014/15 main cropping season at Debine and Umar kulle PA's of Fedis district on FTC for one year. The treatments consisted were nine released varieties from different research centers for midland maize producing agro ecologies of the country. Out of these three were OPV maize varieties (Gibe-1, Gibe-2, and Raaree-1) and six Hybrid maize varieties (Hora, Jibat, QPM, Argane, kuleni, Wanchi) and one local check.

The experiment was laid out as a RCBD design with three replications in a plot size of 3 m × 4 m and the management practices were undertaken as per the recommendation. Seeds were planted in rows with two seeds per hill at a rate of 25 kg/ha in a plot consisting of four row each of 4 m long and 3 m wide and seedlings were thinned into one plant per hill three weeks after emergence to obtain 64 plants per plot. The inter row spacing was 0.75 m, while the intra row spacing was 0.25 m, giving population density of 53,333 plants per hectare. The gross plot size was 4.75 m × 3.3 m (15.675 m^2) and the net plot size 4 m × 3m (12 m^2). Plots and blocks were at the distances of 1 m and 1.5 m apart, respectively.

Fertilizers were 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 after 21 days of planting/.

Data collection

The middle two rows were used for data collection and harvested at maturity. Individual plant base data as well as plot base data were collected on five traits. Data collected on individual plant basis from five randomly selected plants were, plant height (cm), days to tasseling and days to silking. The randomly selected plants were carefully uprooted at physiological maturity to measure growth parameters. Data collected on plot basis were days to maturity and grain yield (qt/ha).

Statistical data analysis

Analysis of variance for the design was carried out using SAS 9.0 software for the parameters studied following the standard procedures outlined by [11]. The level of significance used in 'F' and 't' test was P=0.05. When the treatment effects were found to be significant, the means were separated using the Fisher's protected least significant.

RESULTS AND DISCUSSION

The analysis of variance revealed significant ($P<0.05$) differences in the parameters studied of all maize varieties at both locations. The results revealed that the tallest plant height was obtained by Raree-1 and Kuleni variety Debine with 227 and 210.7 cm, respectively and 242.7 and 229.7 cm at Umarkulle respectively (Table 1). On the other hand, variety Hora was the shortest plant height as compared tested varieties at both locations (Table 1). This result is in the same range with the result reported by the releasing organization Ambo plant protection research center [12].

S.V	df	DM	DS	DT	PH	Yld
Rep	2	24.03	2.8	5.43	354.2	2274718
Variety	9	241.34**	220.76**	186.28**	558.9**	1682281NS
Error	18	16.18	26.80	25.69	209.9	1655445
Total	29					
LSD (P<0.05)		6.9	8.88	8.695	24.85	2207.10
CV (%)		2.6	4.9	5	7.2	31.2

S.V: Source of Variation; df: Degree of Freedom PH: Plant Height; DT: Days to Tasseling; DS: Days to Silking, DM: Days to Maturity; GY: Grain Yield kg/ha

Table 1: The mean squares for different sources of variation and the corresponding CV (%) for 5 characters studied at Debine, in 2014/2015 cropping season

However, this result varies from the study conducted by Bassa and Yasin [13] in southern Ethiopia which reported 209.511, 240.111, 247.4 and 222.2 cm plant height for Hora, Jibat, Kuleni and Wenchi varieties respectively. This might be variation between the two environments.

Maize varieties used in the present study had diverse genetic composition and as a consequence produced results in the parameters studied. Overall, the variation in plant height, days to tasling, days to silking, days to maturity and grain yield observed are due to differences among the variety. However, the variation observed in the parameters studied compared to other location is environmental. Tahir et al. reported that plant height is genetically as well as environmental controlled factor; however the selection of proper crop cultivar manages the influence of environment [14]. Revilla et al. also reported differential pattern of maize varieties for plant height due to genotype and environment interaction [15].

However, plant height has no correlation with grain yield. Olakojo and Iken reported maize varieties differed in plant height but had statistically similar grain yield [16]. Earliest days to tassling were recorded on Gibe-1 and Gibe-2 varieties with 90 and 95 days, respectively at Dabine and 94 and 90.67 days respectively at umerkule (Table 1) while latest days to tussling were recorded on Jibat, local and Wanchi varieties at Dabine with 110.3, 108.7 and 108.3 days, respectively and 105.7, 105.7, 105 and 104.7 days were recorded on Argane, local, Raree-1 and Wanchi at umerkule, respectively. Similarly earliest days to silking were observed on QPM and Gibe-2 varieties on both locations with 94.7 days at Dabine and 94.3 and 95 days at umerkule, respectively.

On the other hand, earliest days to maturing were recorded were by Gibe-2, QPM and Kuleni varieties at Debine taking 142, 143.7 and 144.3 days while it took 143.3, 143.7 and 147 days to reach physiological maturity , respectively at umerkule (Table 2). This result is in line with bako national maize research which reported Gibe-2 variety matures within 143.5 days [17].

At debine, the highest yield obtained were 5325 kg ha^{-1} from Argene followed by local, Jibat and Kuleni with grain yield of 4539, 4512 and 4435 kg ha^{-1}, respectively. Similarly, Argene were the highest yielder at umerkule giving 5531 kg ha^{-1} followed by QPM, local and Jibat yielding 4661, 4517 and 4358 kg ha^{-1}, respectively (Table 3). Although, Argene (AMH-800) variety is the highest yielder at both locations it's below its potential. The releasing organization reported that Argene has potential of 7000-8000 kg ha^{-1} on research field and 5500-6500 kg ha^{-1} on farmer's field [12]. Similarly, Wanchi and Jibat gave yield of 64 and 72 kg ha^{-1} at Bule Hora district of Borena [18] which varies with this finding due to difference in experimental locations. These results depicted that across location variety Argane was significantly higher grain yield advantage by about 16.6% over local check followed by QPM with the value of 0.3%.

S.V	D.f	DM	DS	DT	PH	Yld
Rep	2	15.63	2.80	2.133	89.2	928975.
Variety	9	241.19**	153.837**	136.237**	1431.2**	2625257.*
Error	18	13.26	9.504	4.948	213.2	920173.
Total	29					
LSD (P < 0.05)		6.247	5.288	3.816	25.05	1645.50
CV (%)		2.3	2.9	2.2	7.1	23.8

Key: S.V: Source of Variation; df: Degree of Freedom; PH: Plant Height; DT: Days to Tasseling; DS: Days to Silking; DM: Days to Maturity; GY: Grain yield kg/ha

Table 2: The mean squares for different sources of variation and the corresponding CV (%) for 5 characters studied at Umerkule, in 2014/2015 cropping season

Treatment	Deebinee FTC					U/Kullee FTC				
	PH(cm)	DT (days)	DS (days)	DM(days)	GYLD (kg ha^{-1})	PH(cm)	DT (days)	DS (days)	DM(days)	GYLD (kg ha^{-1})
Argane	198.3^{bc}	107.3^{ab}	114^{a}	162.3^{ab}	5325	199.3^{cd}	105.67^{a}	111.3^{a}	164.7^{a}	5531^{a}
QPM	206.7^{ab}	90^{d}	94.7^{c}	143.7^{ef}	4420	222^{abc}	89.67^{d}	94.3^{d}	143.7^{d}	4661^{ab}
Local	205.3^{ab}	108.7^{a}	114^{a}	162^{ab}	4539	199.3^{cd}	105.67^{a}	111.7^{a}	165^{a}	4517^{ab}
Wanchi	199^{bc}	108.3^{ab}	116^{a}	167.3^{a}	4119	196.7^{d}	104.67^{a}	112^{a}	166.7^{a}	4411^{ab}
Jibat	197.3^{bc}	110.3^{a}	116^{a}	160^{b}	4512	191.7^{de}	102.33^{ab}	107.7^{abc}	163^{a}	4358^{ab}
Kuleni	210.7^{ab}	95^{cd}	100^{bc}	144.3^{def}	4435	229.7^{ab}	91.33^{cd}	96^{d}	147^{cd}	4186^{ab}
Gibe-2	187^{bc}	90^{d}	94.7^{c}	142^{f}	4397	191.7^{de}	90.67^{cd}	95^{d}	143.3^{d}	3883^{b}
Gibe-1	204.3^{ab}	95^{cd}	100^{bc}	149^{cde}	3588	209.3^{bcd}	94^{c}	102.7^{c}	152.7^{bc}	3406^{bc}
Raree-1	227^{a}	103^{abc}	108^{ab}	151^{cd}	3142	242.7^{a}	105^{a}	109.7^{ab}	155.7^{b}	3192^{bc}
Hora	176^{c}	99.7^{bc}	104.7^{b}	152.7^{c}	2093	166.7^{e}	99.67^{b}	105.7^{bc}	155^{b}	2133^{c}
CV%	7.2	5	4.9	2.6	32.9	7.1	2.2	2.9	2.3	23.8
LSD (5%)	24.85	8.695	8.88	6.9	NS	25.05	3.816	5.288	6.247	1645.5

Table 3: Mean comparison grain yield and other growth and phonological parameters of Hybrid maize at Debine and Umar Kulle location

CONCLUSION AND RECOMMENDATION

Three OPV maize varieties (Gibe-1, Gibe-2, and Raaree-1) and six Hybrid maize varieties (Hora, Jibat, QPM, Argane, kuleni, Wanchi) with one local check were evaluated. Thus, it can be concluded that hybrid maize varieties Argane and QPM resulted in best results in terms of yield and yielding component and OPV maize varieties not performed well terms of yield and yielding component as compared to local check. Therefore, for sustainable maize production in the study area Argane and QPM could be recommended. These varieties need to be demonstrated with local varieties to users along with their improved production packages.

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