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STUDY ON ADAPTABILITY OF RELEASED MIDLAND MAIZE VARIETIES AROUND SOUTH ARI WOREDA, SOUTH OMO ZONE, SOUTHERN NATION NATIONALITY PEOPLES REGION, ETHIOPIA

Wedajo Gebre[1] --- Tekle Yoseph[2]

[1,2]Jinka Agricultural Research Centre, South Agricultural Research Institute, Ethiopia

ABSTRACT

Ten released maize varieties were tasted at two sites in randomized complete block design with three replication during 2013 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. ANOVA revealed significant differences ($p<0.05$ and 0.01) between varieties for grain yield at both sites and six characters studied (biomass, plant height, ear length, tassel length and northern corn leaf blight). The significance of varieties difference indicates the presence of variability for each of the characters among the tested entries. The mean grain yield at both sites ranged from 71.7 qt/ha for BH545 to 108.71qt/ha for BH670. Shapi (84.38qt/ha) site was low yielding location than Gumter site (92.31qt/ha). Varieties BH660, BH540, BH140, Gibe -2 and BH670 had high mean grain yield and had good mean performance for yield related traits (biomass, ear length and tassel size), except BH540 that sowed high susceptible to northern corn leaf blight. Variety Gibe-2 is open pollinated; possible for farmers to recycle seed up to five year and also it had relatively high mean grain yield, moderate tolerant to northern corn leaf blight and it was the shortest one. Therefore; Gibe -2 would be highly recommended to growing farmers in the studied area and its vicinity, next the two hybrids; BH540 and BH140 would be recommended from yield point of view with great care of disease especially northern corn leaf blight. Further study should be carried out with disease management and improved varieties to improve maize production with increased yield and biomass production.

Keywords: Adaptation, Hybrid, Maize, Open pollinated varieties, South Ari, South Omo.

1. 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 masl., 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 western 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 [1]

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.

† Corresponding author

Total area covered by maize during the 2006/07 growing season was 1.7 million ha and the national average yield was about 2.2 t ha-1 [2]. In southern region, from the total land size of 1,066,825.51 hectares planted to all grain crops, cereals covered 859,340.71 hectares with a total production of 14,801,477.56 quintals.

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 [3].

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 [4]. 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 regional level jointly by Southern Agricultural Research Institute (SARI) and Bureau of Agriculture in 2008, also confirmed that the yield obtained from the local cultivars is too low. And in many parts of the region, 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 region even do not know the existence of the new crop varieties.

To resolve specific agricultural productivity constraints in the region, several works have been done at regional 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 region. 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 present study was conducted around South Ari Woreda to compare the performance of hybrid, open pollinated and commercial varieties for their adaptability and stability with the following objectives:-

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

2. MATERIALS AND METHODS

2.1. Experimental Site

South Ari woreda belongs to the agro-ecological classification of hot to warm sub-moist lowlands. The woreda is divided into 48 kebeles, it has an average altitude of 1600 m.a.s.l. The

rainfall pattern of the woreda is bimodal. It has average rain fall of 900mm and annually it ranges between 1400-3200mm and the mean annual temperature is 20^{0}c. About 37% of the is 'dega' and 60% 'woina dega', while 3 % is considered as 'Wirch'. The major crops produced in the area are maize, sorghum, barley, wheat, teff, finger millet from cereals, haricot bean, faba bean, field pea, ground nut from pulses and cash crops such as coffee, kororima 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 February/March, the land preparation starts from December. The second season 'Mihere' receive rain fall from Agust and last 2nd weeks of December. Major crops produced during this season are maize, barely, wheat and finer millet in large. The predominant form of crop production in the study area is rain-fed. The productivity of farmland is influenced by the availability of improved technologies and other production factors. As reported that the average productivity of major crops was 20-25, 10-20, and 9-12 quintals per hectare for maize, sorghum and common bean respectively.

2.2. Experimental Materials and Design

The experiment was based on ten released midland maize varieties which were obtained from Bako Agricultural research center. Out of these two varieties namely Gibe- 1and Gibe-2 were open pollinated those obtained through mass selection where as the rest were hybrid varieties. Description of the experimental materials with their yield potential is shown in Table-1 below.

Table-1. Description of ten maize Varieties with their agro-ecological adaptations

Variety	Source/origin	Year of realease	Altitude (masl)	Rainfall (mm)	Days to maturity	Yield (qt/ha)	
						Research station	Farmers field
Hybrid		1995	1,000-2,000	1,000-1,200	145	80-90	50-65
BH540	EIAR	2002					
BH542$^+$	CIMMYT	2005	1,000-1,800	1,000-1,200	145	70-85	50-60
BH543	EIAR/CIMMYT	2008	1,000-2,000	1,000-1,200	148	85-110	55-65
BH545$^+$			1,000-1,800	1,000-1,200	144	80-95	55-60
	CIMMYT						
BH660	EIAR	1993	1,600-2,200	1,000-1,500	160	90-120	60-80
BH661	EIAR/CIMMYT	2011	1,600-2,200	1,000-1,500	160	95-120	65-85
BH670	EIAR	2002	1,700-2,400	1,000-1,500	165	90-120	60-80
BH-140	EIAR	1988	1,000-1,700	1,000-1,200	145	75-85	45-60
OPVs							
Gibe-1	EIAR	2000	1,000-1,700	1,000-1,200	145	60-70	40-45
Gibe-2	CIMMYT	2001	300-1,000	900-1,200	116	65-70	45-50

Source: Proceedings of the Third National Maize Workshop of Ethiopia April 18–20, 2011, Addis Ababa, Ethiopia, OPVs=open pollinated varieties, EIAR= Ethiopian Institute of Agricultural Research, $^+$ = Quality protein maize, BH=Bako hybrid

Randomized complete block design with three replications was used to conduct the experiments per site. Seeds were planted in rows with two seeds per hill at a rate of 25kg/ha in a plot consisting of six row each of 6m long and 5m wide and seedlings were 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 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/.

3. DATA COLLECTION

The middle four rows ($18m^2$) were used for data collection and harvested at maturity. Individual plant base data as well as plot base data were collected on seven traits of maize varieties. Data collected on individual plant basis from five randomly selected plants were, plant height (cm), Ear length (cm), ears per plant, tassel length (cm) and cob weight (gm). The randomly selected plants were carefully uprooted at physiological maturity to measure growth parameters. Data collected on plot basis included grain yield (qt/ha) and biomass (qt/ha).

Disease incidence was recorded from 96 plants in the central four rows of each plot and was converted into the percentage of plants showing symptoms. Disease severity was assessed as proportion of the area covered by lesions on each leaf of 5 randomly taken and tagged plants in the central two rows of each plot and the mean of all leaves was considered as the value for a plot.

4. STATISTICAL ANALYSIS

All necessary data were recorded and being subjected to analysis [5]. Analysis of variance was performed using the GLM procedure of SAS Statistical Software [5]. Effects were considered significant in all statistical if the P-values were < 0.05. Means were separated using Duncan's multiple range (Duncan) test.

5. RESULT AND DISCUSSION

The analysis of variance for the 7 characters studied is given in Table 2. All the characters showed significant ($p<0.05$ and 0.01) difference among the tested varieties. The significance of varieties difference indicates the presence of variability for each of the characters among the tested entries. Also varieties showed significant difference for disease reaction (NCB) at Gumter site.

Thus, varieties respond differently to Northern corn leaf blight effect. Gumter site discriminated between the varieties more effectively (7 characters) than Shapi, because it allows varieties to express their potential fully.

Statistical analysis showed significant differences for grain yield among the varieties. The mean grain yield at both sites (table 3.) ranged from 71.7 qt/ha for BH545 to 108.71qt/ha for BH670 at Gumter site. Gumter site gave high yield of 92.31qt/ha than Shapi site. BH670 gave

highest yield at both sites and showed relatively consistence performance across test sites. BH660 and standard check (BH-140) gave highest yield at Gumter site. Variety BH540 gave highest yield at Shapi followed by BH670 and Gibe- 1 respectively. Similar results were reported by Ahmad, et al. [6] and Souza, et al. [7] who evaluated and identified high yielding maize varieties among different genotypes tested. Akbar, et al. [8] also reported significant differences among maize cultivars for grain yield.

In terms disease (Table 4); Gibe -1, BH540 and BH 543 were severely affected by Northern corn leaf blight. BH542, BH545 and BH140 were moderately affected. Gibe -2, BH670 and BH660 were less affected. The least affected variety was BH661, which showed high tolerance to Northern corn leaf blight.

Table-2. The mean squares for different sources of variation and the corresponding CV (%) for the 7 characters studied at Gumter and Shapi site, in 2013

Trait/characteristics	Varieties (9)	Replication (2)	Error (30)	CV (%)	Mean	R^2
GY	387.23*	882.55**	163.98	13.87	92.30	0.64
BM	1677547.98*	1059271.11*	273783.0	26.23	1994.66	0.77
PH	3016.24**	928.43**	92.12	3.70	259.22	0.94
EL	33.07*	86.77**	9.90	10.10	31.16	0.72
TL	67.62*	11.05Ns	22.67	9.86	48.29	0.60
Cobwt	2129.13*	3939.17**	639.06	18.13	139.40	0.70
NCLB	1560.24***	58.18Ns	168.15	25.84	50.16	0.82
GY at Shapi|Kebele	331.89*	335.69**	95.37	11.57	84.38	0.68

**,* Indicate significance at 0.01, 0.05 probability levels respectively, Ns=not-significantly different, figures in parenthesis refer to degrees of freedom, GY= grain yield (qt/ha), BM= Biomass (qt/ha), PH = Plant height (cm), EL=Ear length (cm), TL= Tassel length (cm), Cobe wt= Cobe weight per plot (gm), and NCLB=Northern corn leaf blight

All varieties showed significant difference for biomass, plant height, Ear length, Tassel length and Northern corn leaf blight. The mean biomass ranged from 1315.6 qt/ha for BH545 to 3520 qt/ha for BH661. BH660 and BH661 gave highest biomass yield followed by BH540 and BH670 respectively. BH660 and BH661 had the highest plant height (311.40a &314.46a) while short saturated plants of (232.06cm &219.20cm) were recorded for variety BH545 and Gibe 2 respectively. As mentioned above table.1, maize varieties used in the present study had diverse genetic composition and as a consequence produced varying plant height ranging from 219.20 to 314.46 cm. Tahir, et al. [9] reported that plant height is genetically as well as environmental controlled factor, however the selection of proper crop cultivar manages the influence of environment. Revilla, et al. [10] also reported differential pattern of maize varieties for plant height due to genotype and environment interaction. However, plant height has no correlation with grain yield. Olakojo and Iken [11] reported maize varieties differed in plant height but had statistically similar grain yield.

Table-3. Mean grain yield (qt/ha) of verities over locations during 2013

No.	Varieties	Gumter site	Shapi site	Variety mean
1	BH540	94.40abc	104.11a	99.26
2	BH542	89.07abc	82.07c	85.57
3	BH543	83.41bc	83.08c	83.25
4	BH545	71.70c	73.75c	72.73
5	BH660	106.68ab	74.07c	90.38
6	BH661	88.80abc	82.72c	85.76
7	BH670	108.71a	101.81ab	105.26
8	Gibe-1	84.12abc	85.20bc	84.66
9	Gibe-2	94.83abc	77.16c	86.00
10	BH-140	101.33ab	79.78c	90.56
Site mean		92.31	84.38	
CV(%)		13.87	11.57	
Critical Range		(21.97, 25.29)	(16.75, 19.29)	

BH=Bako hybrid, a=highest, b=medium, c=poor, d=poorest, e=bad mean performance, varieties having same letters are same in mean performance for grain yield.

Varieties BH670 and BH660 had longest ear and tassel length respectively (Table 4). Varieties BH540, BH140 and Gibe-2 had shortest ear length. BH542 had shortest tassel length while BH540, BH543, BH545, Gibe-2 and BH-140 had medium tassel length.

Table-4. Mean performance ten verities at Gumter site, 2013

Variety	BM(qt/ha)	PH(cm)	EL(cm)	TL(cm)	NCLB(scale)
BH540	2026.7b	248.13cd	28.20d	49.13abc	74.20ab
BH542	1635.6b	252.53c	28.80cd	41.13c	45.67cd
BH543	1671.1b	241.26cd	32.13abcd	44.53bc	66.33abc
BH545	1315.6b	232.06ed	34.26abc	46.40bc	45.00cd
BH660	3200.0a	311.40a	35.13ba	56.80a	38.00d
BH661	3520.0a	314.46a	30.73bcd	51.33ab	7.60e
BH670	2026.7b	273.00b	37.00a	52.53ab	41.33d
Gibe-1	1493.3b	256.80bc	29.73cd	51.20ab	89.33a
Gibe-2	1600.0b	219.26e	27.66d	43.80bc	37.00d
BH140	1635.6b	243.26cd	28.00d	46.06bc	57.20bcd
CV(%)	26.23	3.70	10.10	9.86	25.84
Critical range	(898,1034)	(16.46,18.96)	(5.4,6.21)	(8.16,9.40)	(22.24,25.61)

a=highest, b=medium, c=poor, d=poorest, e=bad mean performance, varieties having same letters are same in mean performance for that trait. BM=Biomass (qt/ha), PH = Plant height (cm), EL=Ear length (cm), TL= Tassel length (cm) and NCLB=Northern corn leaf blight

6. SUMMERY AND CONCLUSION

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 masl., from moisture deficit semi-arid lowlands, mid-altitude and highlands to moisture surplus areas in the humid lowlands, mid-altitudes and highlands. 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 [3].

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.

Ten released maize varieties were tasted at two sites in randomized complete block design with three replication during 2013 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.

Significant differences between varieties were observed for grain yield at both sites and six characters studied (biomass, plant height, ear length, tassel length and northern corn leaf blight).

The mean grain yield at both sites ranged from 71.7 qt/ha for BH545 to 108.71qt/ha for BH670. Shapi (84.38qt/ha) site gave low yield than Gumter site (92.31qt/ha). Based on mean grain yield, BH670, BH540, BH140 and BH660 gave highest yield across both sites (Table 3).

At Gumter site (Table 4) the mean biomass was ranged from 1315.6 for BH545 to 3520 qt/ha for BH661. Accordingly, BH660 and BH661 gave highest biomass followed by BH540 and BH670 respectively. The tallest varieties were BH660 and BH661 while the shortest variety was Gibe-2, and the mean plant height was ranges from 219.26 for Gibe-2 to 314.46 for BH661. Mean ear length ranged from 27.66 for Gibe-2 to 37.0 for BH670 and mean tassel length ranged from 41.13 for BH542 to 56.80 for BH660 respectively. Varieties BH670, BH660, BH545 and Gibe-2 showed high tolerance to northern corn leaf blight but Gibe-1, BH540 and BH543 showed susceptible to north corn leaf blight.

In general, varieties BH660, BH540, BH140, Gibe -2 and BH670 had high mean grain yield and had good mean performance for yield related traits (biomass, ear length and tassel size), except BH540 that sowed high susceptible to northern corn leaf blight. But varieties BH660 and BH670 had highest mean plant height; which implies varieties are susceptible to lodging and also they take long time to mature (Table 1.). Variety Gibe-2 is open pollinated; possible for farmers to recycle seed up to five year and also it had relatively high mean grain yield, moderate tolerant to northern corn leaf blight and it was the shortest one. Therefore; Gibe -2 would be highly recommended to growing farmers in the studied area and its vicinity, next the two hybrids; BH540 and BH140 would be recommended from yield point of view with great care of disease especially northern corn leaf blight. Further study should be carried out with disease management and improved varieties to improve maize production with increased yield and biomass production.

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