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Growth and Grain yield Response of maize varieties to conservation tillage in southern Ethiopia

Legesse Hidoto

***Abstract*— Shortage of additional land for crop production, lack of crop varieties, decreased soil fertility and declining yield for major food crops have been cited as the major concerns for agriculture's ability to provide nourishment for the increasing population. Prioritization of cost reducing, yield enhancing and resource conserving farming methods is vital to catalyze a shift towards sustainable and resilient maize cropping systems. A field experiment was conducted at three selected districts of Southern Nations Nationalities and People'sRegion during 2017and 2018cropping seasons with the objective toevaluate the growth and grain yield response of maize varieties to conservation tillage. The experiment was laid out in randomized complete block design consisting of five varieties (016K-SPRH, 016k-SBRH, BH-540, BH-546, and BH-547)within three replications. Pre planting herbicidesprayed to control pre emerged weeds.Growth and yield parameters of maize were measured. Crop residues were retained in no-till plots, whereas they were removed from conventional tillage plots in line with current farmer practices. Maize yield data was obtained from plots under no-tillage as well as from conventionally tilled plots. Combined analysis of variance over 2017 and 2018 across locations revealed that the maize BH-546 and BH-547 had higher grain yield (5.2 and 5.0 t ha-1), but not significantly higher than the BH 540 (4.9 t ha-1). The highest plant height (208cm), ear height(108cm) with statistically similar above ground biomass of the varieties (016K-SPRB and 016k-SBRH)to that of the hybrids indicated the potentialfor further research. Moreover, conservation tillage cannot affect the performance of maize growth and yield across locations over years.**

***Index Terms*— candidate,conservation, conventional, districts, genotype, variety .**

I. Introduction

Maize (Zeta mays) is one of the most important cereal crops in the world which is ranked second to wheat production, first in Africa and Latin America but third after rice and wheat in Asia. Globally, maize is grown over an area of 193 million hectares with production of 1.15billion tons annually [1](FAOSTAT,2018).

The crop is the most important staple crop in the region, feeding more than 200-300 million people across Africa and providing food and income security to millions of smallholder farmers. In Ethiopia, itis grown on over 2 million hectares and ranked first among cereal in total production and productivity.

According to the Central statistical agency [2]report of the country, maize covered 22.9 % (2.37 million hectares) of the cereal crop area and contributed to 34.2% (94.5 million tons) of the cereal production. In Southern Nations, Nationalities and Peoples Regional State (SNNPRS) of Ethiopia, maize covered 37 % (322714.36 hectares) of the cereal crop area and contributed to 51% (1085725.6tons) of the cereal production with 3.36t ha^{-1} productivity [3]. In spite of the enormous uses of maize and higher volume of production, its productivity in the region is generally low, ranging from 2.2 t ha^{-1} (Segenpeople's zone) to 4.0 t ha^{-1} (Silte zone[3] . This is far below the potential yield of maize that could be achieved with the currently available technologies in the country. The world agricultural scenario indicates that food security is the overriding concern of every nation. All technological advances in both developed and developing countries must gear towards increasing food production. Both the large-scale, specialized commercial agriculture and small-scale mixed semi-subsistence types of agriculture play vital roles to attain this objective. Prioritization of cost reducing, yield enhancing and resource conserving farming methods is vital to catalyze a shift towards sustainable and resilient maize agri-food systems.

Shortage of additional land for crop production, lack of crop varieties, decreased soil fertility and declining yield for major food crops have been cited as the major concerns for agriculture's ability to provide nourishment for the increasing population. Increased yield, disease resistant and quality are the ultimate goals in almost any crop improvement programs. However, it seems that reasonable yields with few risks are preferable than high yields with high risks to the resource poor farmers living in the tropics under highly variable environments. Conservation agriculture (CA), isbased on minimum soil disturbance, permanent soil organic cover, and the use of diverse crop rotations/associations, has the potential for addressing the current food insecurity and soil degradation on smallholder farming systems [4].Thus, the present study initiated to evaluate maize varieties compatible under conservation tillage to provide sustainable yield without degrading the farm land through repeated plowing.

Materials and methods

Study areas

Field experiments were conducted during 2017 and 2018 cropping seasons at three locations namely; Halaba onstation with clay loam textured soil having pH 6.8 =, EC = 0.08 ds/m, total N (%) = 0.44, available P = 37.6 ppm) and altitude of 1800 m.a.s.l. whereas, Boricha located at 6.93^{o} latitude of and 38.42^{o}longitude having initial soil pH value of 6.32, 2.44 OC, 0.17 total N and 25.93 CEC, and Loka abaya having 7.10^{o}latitude and 38.15^{o} longitude with 6.15 pH, 2.75 OC, 0.20 total N, and 24.88 CEC, using farmers field as representing location in Southern region of Ethiopia. There is bimodal rainfall pattern locally termed belg (short rainy

LegesseHidoto (PhD), Director, Crop Research directorate,South Agricultural Research Institute, Hawassa, Ethiopia

season starting from February and ends late May) and meher (main rainy season starting from early June and ends late September).

Experimental design and treatments

Treatments consisted of five maize varieties include 016K-SPRH, 016k-SBRH, BH-540, BH546, and BH547, which areintermediate maturing, three-way cross hybrids released for high-potential maize growing areas (Table 1). The treatments were laid out in a randomized complete block design (RCBD) with three replications. Pre emergence herbicide(roundup) was sprayed a week before sowing of maize to control and facilitate weed free field for ease of making rows to plant. Planting was carried out soon after the onset of rainfall and planting time of respective areas. A 4 x 4 m plot size used and maize was planted at inter and intra row spacing of 80 and 25 cm, respectively. Two seeds were placed per hill and after emergence seedlings were thinned to maintain 80 plants per plot. The recommended phosphate in forms NPS was applied at planting whereas N fertilizer applied in split where the first half at planting and second half applied 40 days after planting. Weeding and cultivation were carried out as desired during growing season.

Table 1. Description of maize varieties tested for their growth and yield performance under conservation tillage

variety	Year of release	Altitude (masl)	Rainfall (mm)	Yield (kg ha^{-1})	
				Research field	Farmers field
BH540	1995	1000_2000	1000_1200	80_90	50_65
BH546	2013	1000_2000	1000_1500	85_115	65_75
BH547	2013	1000_2000	1000_1500	85_115	65_75
SPRH1	2015	1000_1800	1000_1200	85_95	55_65
SBRH1	2015	1000_1800	1000_1200	75_85	55_70

masl=meter above sea level

Data collection

Data recorded were plant height, ear height, above ground biomass yield, thousand seed weight, and grain yield. Harvest Index was calculated as grain yield divided by its biomass yield. Plant heightand ear height were measured for five randomly selected plants per plot. Grain was manually harvested from central rows and converted to kg ha^{-1} after adjusting the moisture content to 12.5%. Biomass yield was estimated as the sum of stover weighed and grain yield.Thousand seed weight (TSW) was measured by counting a thousand seeds manually and weighing it with sensitive balance.

Data analysis

Data were combined across locations over years after carrying out the homogeneity test of variances [5] and subjected to analysis of variance using the general linear model SAS version 9.4[6]. Treatment means were compared using the least significant difference (LSD) at 5% level of significance.

Results and discussion

As presented in table 2 most of the growth and yield parameters tested were statistically significant due to the effects of year, location, variety and year by location interaction. The interaction between year X variety and location X variety were highly significant only to thousand seed weight.

Table. 2. Mean square values of plant height, ear height, aboveground biomass, thousand seed weight, grain yield and harvest index response of maize varieties to conservation tillage during 2017 and 2018 cropping season.

Source of variation	df	Plant height	Ear height	Biomass yield	Grain yield	Seed weight	Harvest Index
Year (Y)	1	8624**	1000**	12.5ns	29.4**	1174ns	0.11**
Location (L)	2	13676**	5556**	128**	14.6**	10242**	0.00ns
Variety (V)	4	1019**	1145**	25**	2.3*	12497**	0.00*
Y*L	2	15751**	9340*	156**	14.7**	36777**	0.02**
Y*V	4	265ns	341*	4.5ns	0.37ns	2060**	0.00ns
L*V	8	197ns	223ns	3.6ns	1.21ns	2200**	0.00*
Y*L*V	8	329ns	189ns	1.37	0.54ns	716ns	0.00ns
CV%		8.18	11.22	18.62	19.42	9.42	10.22

The effect of Year on growth and yield of maize varieties

The effects of year on plant height, ear height, grain yield and HI were significant where 2018 provide significantly better than 2017 across the parameters (Table 3).The most probable reason for this difference is amount and distribution of rainfall, which was better during 2018 than that of 2017 (Fig.1).Bimodal rainfall pattern is common, but the spread over the months differs between areas. There are 'good' rainfall years and 'bad' rainfall years which are defined not only by variations in overall precipitation but by irregularities such as a late start to the *belg* rains which seriously delays maize seeding or dry spells at critical periods of growth which much reduce the grain or tuber formation in plants that otherwise look quite healthy. CA can potentially make a difference in situations of erratic rainfall distribution characterized by mid-season dry spells where higher moisture conservation during critical crop phases may increase crop yields at harvest or at least reduce the risk of complete crop failure [7](Thierfelder and Wall, 2010).In the lowlands it is not always clear what is real rainfall 'irregularity' and what is within a locally quite normal range of inter-annual variation. Total precipitation of Halaba and Boricha where the experiments conducted during the year 2018 was better than the year 2017. For instance, the total rainfall for the year 2018 at Halaba was greater by 410mm than the year 2017.Similarly, at Boricha during 2018 was greater by 834mm to that of 2017. While at lokaabay, the amount of rainfall was only 1.6% less than the year 2017. As presented in Fig. 1., early onset of rain during 2018 and its even distribution during the growing season allowed the crop good performance.

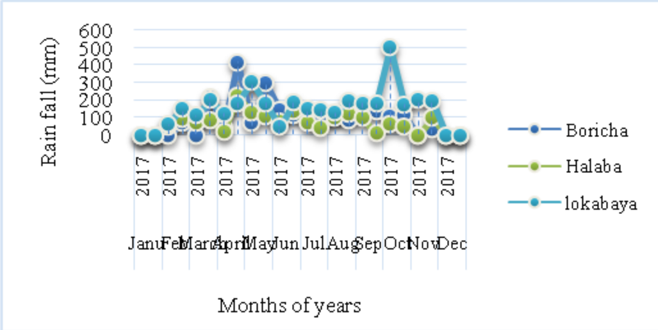

Fig.1. Monthly rainfall(mm)across locations over 2017 and 2018

Source: Southern district Meteorology station, Hawassa

Table3. Mean values of plant height, ear height, above ground biomass, grain yield, thousandseed weight and harvest index response of maize varieties to conservation tillage during 2017 and 2018cropping season

Year	Plant height (cm)	Ear height (cm)	BiomassY (ton/ha)	Grain Y (ton/ha)	1000 Seed weight(g)	HI
2017	190b	101b	13.28	4.20b	263	0.32b
2018	210a	107a	14.03	5.34a	271	0.38a
LSD	7	5	NS	0.39	NS	0.02

The effect of Location on growth and yield of maize varieties

As presented in table 2, the effects of location on growth and yield of maize varieties were significant where its performance was better atBoricha and Lokaabayathan Halaba. However, the grain yield obtained at Halaba(3.96 ton)was by 8, 15and 7% higher than the national, regional and zonal productivity (3.68, 3.36, and 3.67ton ha^{-1}), respectively (Table 4).

Table 4. Mean values of plant height, ear height, above ground biomass, grain yield and thousand seed weight response of maize varieties to conservation tillage across locations during2017 and 2018 cropping season

Location	Plant height (cm)	Ear height (cm)	Biomass Yield (t/ha)	Grain Y (t/ha)	1000 Seed weight(g)	HI
Halaba	175b	88b	11.28b	3.96b	249c	0.34
Lokaabaya	211a	111a	14.69a	5.14a	266b	0.35
Boricha	213a	113a	14.99a	5.20a	286a	0.36
LSD%	8	6	1.31	0.49	13	0.02

The effect of varieties on growth and yield of maize

Combined analysis of variance over 2017 and 2018 across locations revealed that the maize BH546 and 547 had significantly higher grain yield (5.2 and 5.0 t ha^{-1}), but not significantly higher than the BH 540 (4.9 t ha^{-1}). Similarly, Improved varieties of maize significantly superior than the local one [9]. Although 016K-SPRB and 016k-SBRH gave lower yield than the hybrids, statistically expressive performance in growth where highest plant height (208cm), ear height (108cm) with statistically similar above ground biomass with the Bako hybrids (Table 5). Conservation tillage not affected the growth and yield of maize varieties. All the varieties evaluated under conservation tillage with the objectives to see their performance under no till system. In the study presented by Daniel and Legesse[8], indicated that the biomass yield obtained from conservation tillage plots was higher by 6 tons than the ones from conventional practices. Similarly, Thierfelder et al.,[4]pointed out that maize yields under conventional cropping systems were more affected by the variability of rainfalls than conservation agriculture systems highlighting greater resilience of CA cropping systems to a variable climate, especially rainfall.

Table5. Mean values of plant height, ear height, above ground biomass, grain yield and thousand seed weight response of maize varieties to conservation tillage

Variety	Plant height (cm)	Ear height (cm)	Biomass Yield (t/ha)	Grain Y (t/ha)	1000 Seed weight(g)	HI
016K-SPRH	188b	90b	12.25cd	4.37c	229d	0.36ab
016K-SBRH	208a	108a	13.59b	4.41bc	282ab	0.33d
BH-540	201a	104a	12.72c	4.86abc	297a	0.37a
BH-546	202a	107a	14.97a	5.18a	255c	0.35bcd
BH547	201a	110a	14.75ab	5.00ab	273b	0.34cd
LSD%	11	8	1.69	0.62	17	0.02

The effect of location and year on growth and yield of maize varieties

Significant growth and yield variation of tested maize varieties due to the variation in location both during 2017 and 2018 (Table 6). The highest plant height(228cm), 128cm ear height, and 17.01ton ha^{-1} above ground biomass obtained at Borich during 2017 cropping season while the highest grain yield of 5.44-ton ha^{-1} was from LokaAbaya during 2018 (Table 6).

Table6. The effect of location and year interaction on plant height, ear height, above ground biomass, grain yieldand thousand seed weight of maize varieties to conservation tillage across locations over two years (2017 and 2018)

Year X location	Plant height (cm)	Ear height (cm)	Biomass Yield (t/ha)	Grain Yield (t/ha)	1000 Seed eight(g)	HI
Halaba 2017	145	68	8.75	2.60	209	0.29
Lokaabaya 2017	198	106	14.10	4.84	265	0.34
Boricha 2017	**228**	**128**	**17.01**	5.15	316	0.30
Halaba 2018	206	108	13.81	5.33	289	0.39
Lokaabaya 2018	225	116	15.29	**5.44**	266	0.36
Boricha 2018	198	97	12.98	5.24	257	0.41
Mean	200	104	13.65	4.77	267	0.35
SE_{mean}	11.15	7.61	1.04	0.40	13.29	0.02

Pearson Correlation Coefficients

The results of correlations are shown in Table 6. In this study, there was significant positive correlation between grain yield and almost all growth and yield components (plant height, ear height, above ground biomass and thousand seed weight.However, HI was not correlated with either of the parameters. These findings coincide with the results of several workers (Annapurna, D., [10];Khatun,F.,[11];Mohammad, [12] and Bello et al.[13] Plant height had positive and highly significant correlation with most of the tested characters. The same author reported that significant positive correlation between grainyield and plant height. High correlation of grain yield with plant height is alsoreported by Annapurna et al. [10] and Gautam et al. [14] . HI correlated significantly only with seed weight and grain yield.

Table 6. Pearson Correlation Coefficients for growth and yield of maize varieties tested

	Plant height	Ear height	Biomass	Seed weight	Yield	HI
Plant height	1	0.91**	0.77**	0.65**	0.73**	0.17ns
Ear height		1	0.76**	0.66**	0.67**	0.06
biomass			1	0.52**	0.84**	-0.01
seed Weight				1	0.53**	0.22*
yield					1	0.52**
Harvest Index						1

** = highly significant with p<0.0001

Conclusion

The results of present study revealed that tested maize varieties exhibited superior performance at Boricha followed by Lokaabaya for growth and grain yield whereas their performance was lower at Halaba. Maize BH546 and BH547 had higher grain yield (5.2 and 5.0 t ha^{-1}), but not significantly higher than the BH 540 (4.9 t ha^{-1}). Although the varieties 016K-SPRB and 016k-SBRH gave lower yield than the BH varieties, statistically meaningful performance observed in growth across locations over years. The highest plant height (208cm), ear height (108cm) with statistically similar above ground biomass of the varieties 016K-SPRB and 016k-SBRH with BH546, BH547 and BH540 indicated the maize varieties not affected to conservation tillage rather the tested materials showed adaptive performance for further study under the tillage system.

REFERENCES

[1]. Food and Agriculture Organization of the United Nations (FAOSTAT,2018).

[2]. CSA (Central Statistics Agency) Agricultural Sample Survey 2017/2018. Volume I. Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season). Statistical Bulletin 586. Addis Ababa, 2018.

[3]. CSA (Central Statistics Agency). Agricultural Sample Survey Volume I. Report on Addis Area and Production of Major Crops (Private Peasant Holdings, Meher Season). Statistical Bulletin 532, Addis Ababa.2017.

[4]. Thierfelder, C., Rusinamhodzi, L., Ngwira, A. R., Mupangwa, W., Nyagumbo, I., Kassie, G. T., & Cairns, J. E. Conservation agriculture in Southern Africa: Advances in knowledge. Renewable Agriculture and Food Systems, 1-21. 2014.

[5]. Gomeze A and Gomez A. Statistical procedure for agriculture research. 1984.

[6]. SAS (Statistical Analysis System Institute. SAS/STAT user's guide. Proprietary software version 9.4. SAS Inst Inc Cary NC). 2017.

[7]. Thierfelder, C.andWall,P.C. Investigating conservation agriculture(CA)systems in Zambia and Zimbabwe to mitigate future effects of climate change. J.crop improv. 24,113_121. 2010.

[8]. Daniel M., and Legesse H. Towards sustainable maize legume cropping system s: conservation agriculture-based intensification. 2019.

[9]. ESA (Ethiopian Seed Association). Hybrid maize seed production manual. 2014.

[10]. Annapurna,D., H.A. Khan and S. Mohammad,Genotypic–phenotypic correlations and path coefficient Analysis between seed yield and other associated characters in tall genotypes of maize. Crop Res.Hisar. 16: 205-9. 1998.

[11]. Khatun, F., S. Begum, A. Motin, S. Yasmin, M.R. Islam, Correlation coefficient and path analysisof some maize (Zea mays L.) hybrids. Bangladesh J. Bot. 28: 9- 15. 1999.

[12]. Muhammad, B.A., R. Muhammad, S.T. Muhammad, H. Amer, M, Tariq and S. A. Muhammad, Character association and path coefficient analysis of grain yield and yield Components in maize. Pak. J.Biological Sci 6(2): 136-138. 2003.

[13]. Bello, O.B., S.Y. Abdulmaliq, M.S. Afolabi, and S. A.Ige, Correlation and path coefficient analysis of yield and agronomic characters among open pollinated maize varieties and their F1 hybrids in a diallel cross. African Journal of Biotechnology, 9(18): 2633-2639. 2010.

[14]. Gautam, A. S., R. K. Mittal and J.C. Bhandari, Correlations and path coefficient analysis in maize (Zeamays L.). Ann. Agric. Biol. Res. 4: 169-71. 1999.