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Performance Evaluation and GGEbiplot Analysis of Sesame (*Sesamum indicum* L.) Genotypes in Eastern Ethiopia

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Abstract: Sesame is a food source, an oil, and a cash crop. Despite the fact that Ethiopia has a lot of potential for sesame production. The average sesame seed yield is very low due to a lack of high yielding improved sesame variety/ies. As a result, the objectives of this study were to evaluate the performance of sesame genotypes and GGEbiplot analysis; in a randomized complete block design with three replications. Fifteen sesame genotypes including standard check (Adi) were tested during the main cropping season (2014, 2015 and 2016) at three sesame growing locations: Werer, Bonta (Arage) and Miesso. Analysis of variance (ANOVA) revealed significant differences at $P<0.05$ was observed, signifying the presence of genotypic disparity among the tested sesame genotypes. Sesame genotypes differed significantly in terms of days to maturity, plant heigh and number of pods per plant, 1000 seed weight and seed yield per hectare. Serkamo white (G12) and Acc-44(1) (G14) genotypes outperformed the others. As a result, it had a higher grain yield and white seed color than the other genotypes tested. Because of their high seed yield and white seed color. Finally, Serkamo white (G12) genotype is expected to attract high external market preferences and prices, contributing to the future sesame export market.

Keywords: Genotype, GGEbiplot, Sesame, Variety, Yield

1. Introduction

Sesame (*Sesamum indicum* L.) belongs to the Pedaliaceae family and the genus Sesamum, allowing to evidence, Ethiopia is the origin of cultivated sesame [1]. The cultivated sesame is a diploid species with two pairs of chromosomes (2n=2x=26) [2]. It is the most important oil crop that can thrive in tropical and subtropical climates [3, 4].

Sesame is grown in over 78 countries across six continents, covering an area of approximately 14 million hectare and producing approximately 6.8 million metric ton in 2020 [5]. Sudan, India, China, Myanmar, Nigeria, the United Republic of Tanzania, Ethiopia and Uganda are the world's leading sesame seed producers. Similarly, sesame is grown on 9.7 million hectare in Africa, with a total production of 4.3 million metric ton and a 42.5 percent yield African accounts for a portion of sesame production. However, in Ethiopia production/yield quantities of sesame seed have been decreasing from 2010 to 2020 [5].

Sesame seed can contain up to 50% oil and 25% protein [4]. It is an important oil crop in Ethiopia and; for the national economy as an industrial crop, a source of oil, food and feed, and a cash crop; despite the fact that production and area harvested have been declining since 2010 (Figure 1). Ethiopia's major sesame growing regions include North Gonder, Western Tigray, Pawe, Blese, Assosa, and Wellega. While; Gibe valley, Jinka plain, and North Omo lowlands are potential growing areas for future sesame in Ethiopia [4].

Ethiopia's average sesame productivity is very low in comparison to the rest of the world. Many factors contribute to its failure, including: high yielder improved/climate resilience sesame variety/ies in particular, indeterminate flowering nature, capsule shattering at maturity, and biotic and abiotic stresses [4]. However, there is a lot of untapped potential in sesame production.

The Ethiopian Institute of Agricultural Research (EIAR) began sesame improvement research in Ethiopia in the late 1990s at Werer Agricultural Research Center (WARC); in three agro-ecological zones (irrigated, high, and low rainfall) to meet the needs of specific regions. Working materials were also designed to meet specific goals, such as white seed coat, earliness, non–shattering, high yield, and resistance to bacterial blight. The goal is to create potential cultivars that meet the needs of sesame growers, processors and consumers [4, 6, 7]. Many experts believe that the best way to overcome the constraints is to variety more adaptable and productive sesame cultivars. In general, sesame exhibits a high genotype x environment interaction (GEI) in multi-environment trials (MET). A high GEI has an impact on breeding effectiveness. To improve crop breeding selection efficiency, it is necessary to understand and assess genotype and GEI influences. Furthermore, MET aids in the identification of genotypes with significant adaptation or adaptation to a specific environment [4, 7]. As a result, the purpose of this study were to compare the performance of sesame genotypes to that of among genotypes and a standard check and GGEbiplot analysis.

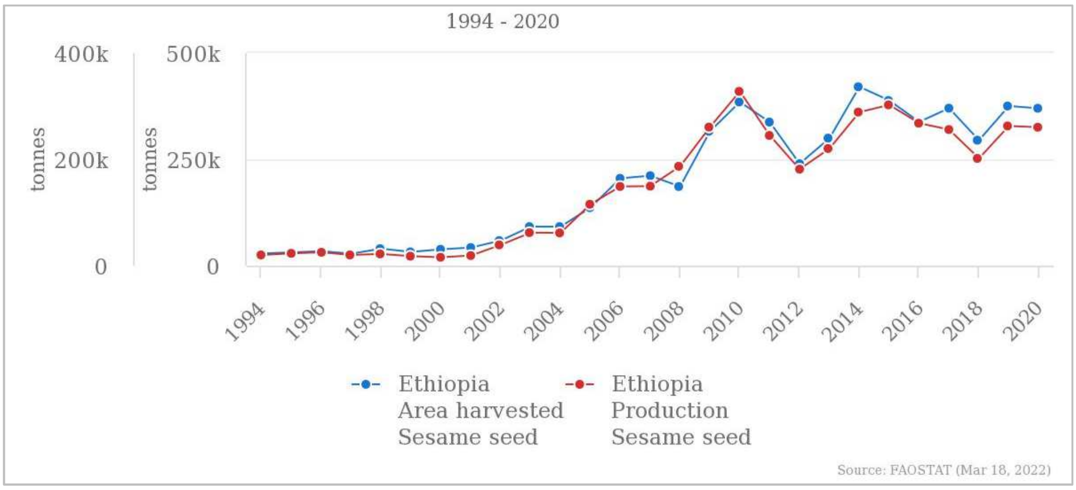

Figure 1. *Production/yield quantities of sesame seed in Ethiopia.*

2. Materials and Methods

The experimental site is described in detail. The experiment was carried out in Werer and Bonta (*Aragae*) in Afar State, as well as Miesso in Eastern Harergae and Oromia State of Ethiopia's sesame growing areas, for three years from 2014, 2015 and 2016.

Table 1. *Test locations, the trial were conducted during each year.*

Locations	No. Locations	Number of test genotypes in the trial
Werer, Bonta (*Arrage*)& Miesso	3	15
Werer, Bonta (*Arrage*)& Miesso	3	15
Werer, Bonta (*Arrage*)& Miesso	3	15

Management and design of experiments

The experiment used a randomized complete block design (RCBD), with three replications at each testing site. Each genotype was assigned at random and sown in a 2m x 5m plot area, with 1m between plots and 1.5m between blocks, and inter and intra row spacing of 40cm and 10cm, respectively. Each plot had a total area of $10m^2$ and five rows, with a net plot area of $6m^2$ and three harvestable rows, and all management was done equally and properly in accordance with the study area' recommendations. The experiment included fifteen promising sesame genotypes including the standard control "Adi". These fifteen sesame genotypes were evaluated at the national variety trial level in lowland oil crop breeding and genetics department.

Data for the plot base were collected from the three middle harvestable rows; while, five representative plants were chosen at random and tagged to collect all of the agro-morphological data for the plant base for each genotype at each test environment. Days to 75% maturity (DM): The number of days between the time of emergence and the time when 75% of the plants in each plot had fully matured. Plant height (PH) in centimeters: A meter tape was used to measure this growth parameter from the ground surface to the top of five randomly selected and tagged plants from each plot's harvestable rows. Number of pods produced per plant (PPP): Five plants were chosen at random and their pods were counted. TSW (thousand seed weight): the gram weight of 1000 sesame seeds. Grain yield per hectare (kg_ha): Using a sensitive balance, the total grain yield harvested from the net plot area was weighed and converted to kilogram per hectare.

Table 2. *Background information regarding the experimental material and their environments.*

No	Genotypes	Genotype Cod	Seed Sources	Status of the Genotypes	No	Testing location	Year	Environment
1	Acc -00048	G1	WARC	Advanced Lines	1	Werer	2014	E1
2	Acc -00001(1)	G2	WARC	Advanced Lines	2	Bonta (*Arrage*)	2014	E2
3	Acc -00002	G3	WARC	Advanced Lines	3	Miesso	2014	E3
4	Acc -00015	G4	WARC	Advanced Lines	4	Werer	2015	E4
5	Acc -00033(1)	G5	WARC	Advanced Lines	5	Bonta (*Arrage*)	2015	E5
6	Acc -00032	G6	WARC	Advanced Lines	6	Miesso	2015	E6
7	Acc -00016(1)	G7	WARC	Advanced Lines	7	Werer	2016	E7
8	Acc -00025	G8	WARC	Advanced Lines	8	Bonta (*Arrage*)	2016	E8
9	Acc -00044(2)	G9	WARC	Advanced Lines	9	Miesso	2016	E9
10	Acc -00049	G10	WARC	Advanced Lines				
11	Adi (Check)	G11	WARC	Released Variety				
12	Serkamo white	G12	WARC	Advanced Lines				
13	Acc -00024(1)	G13	WARC	Advanced Lines				
14	Acc -44(1)	G14	WARC	Advanced Lines				
15	Acc -00035	G15	WARC	Advanced Lines				

Data analysis: Analysis of variance (ANOVA) for yield and yield-related components was performed for the combined analysis using R and Gnstat 18th for graphical visualization. The model: Yijk = + Gi + Ej + GEij + Bij + ijk was used for the analysis of variance of a randomized complete block design; where is the mean, Gi represents the effect of the ith genotype, Ej represents the effect of the jth environment, GEij represents the interaction of the ith genotype with the jth environment, Bij represents the effect of the kth replication in the jth environment, and ijk represents the random error.

3. Results and Discussion

3.1. Analysis of Variance and Mean Performance of Agronomic Traits

Analysis of variance (ANOVA) revealed significant differences ($P<0.05$), indicating the presence of genotypic variation among the tested sesame genotypes (Table 3). ANOVA highly significant differences in days to maturity, plant height, number of pods per plant, 1000 seed weight, and seed yield per hectare among sesame genotypes; and also similar results were reported [8, 9]. The combined analysis of variance of three years of data from Werer, Bonta (*Arrage*) and Miesso revealed that the grain yield performances of promising genotypes are significantly affected by year and location.

Sesame seed yield: Serkamo white, Acc-44(1), and Acc-00024(1) performed best at Werer, Bonta (*Arage*) and Miesso. The interaction of genotypes with the environment is a critical factor that discourages breeders and geneticists because it complicates the plant variety development program for most crops in order to produce a stable variety across locations and seasons. Ethiopia has diverse environmental conditions in terms of altitude, soil type, climate variability, making Ethiopia's plant-breeding program difficult to develop stable varieties with greater adaptability. The average sesame seed yield ranged between 930 and 1218 Kg_ha. The genotype Serkamo white produced the highest mean yield; while, genotype Adi and Acc-00033(1) produced the lowest seed yield (Table 3).

Table 3. *Mean sesame seed yield of the genotypes at Werer, Bonta (Arage) and Miesso (Yield kg_ha).*

No	Treatment	Yield (kg_ha) Loc: Werer				Yield (kg_ha) Loc: Bonta (*Arage)*				Yield (kg_ha) Loc: Miesso				Over all mean
		2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean	
1	Acc -00048	1307	1615	1307	1396	945	1169	964	1026	907	608	552	689	1037
2	Acc -00001(1)	1503	1673	1503	1433	1213	1479	985	1227	1049	613	599	754	1137
3	Acc -00002	1330	1443	1330	1346	979	1120	1201	1100	1104	755	552	804	1083
4	Acc -00015	1467	1590	1467	1355	1059	1294	987	1113	873	479	566	639	1036
5	Acc -00033(1)	1348	1458	1348	1303	941	884	979	935	950	640	459	683	973
6	Acc -00032	1209	1601	1209	1358	843	1348	1035	1075	1123	619	380	707	1047
7	Acc -00016(1)	1362	1798	1362	1483	978	1412	1121	1170	961	498	608	689	1114
8	Acc -00025	1185	155	1185	1351	964	1255	979	1066	771	645	516	644	1020
9	Acc -00044(2)	1529	1687	1529	1440	1008	976	1008	997	774	484	528	595	1011
10	Acc -00049	1257	1665	1257	1430	1337	1279	1044	1220	955	497	476	643	1098
11	Adi	1193	1423	1193	1251	583	1190	852	875	970	607	420	665	930
12	Serkamo white	1338	1723	1337	1571	1310	1568	1021	1299	1167	718	463	783	1218
13	Acc -00024(1)	1356	1872	1356	1522	906	1351	1176	1144	1082	488	487	686	1117
14	Acc -44(1)	16.09	1817	1609	1572	127	1091	1041	1134	835	579	889	768	1158
15	Acc -00035	1175	1525	1175	1327	889	1400	1071	1120	946	808	672	809	1085
	Mean	1345	1629	1345	1409	1015	1254	1031	1100	964	602	545	704	1071
	CV	6.18	14.34	6.18	13.77	17.35	25.97	9.15	20.96	15.03	24.17	31.04	23.9	17.80
	LSD	139	391	139	1812	2945	545	158	215	242	244	283	157	102

Where; Kg=kilo gram, Loc=location, ha= hectare, CV=coefficient of variation and LSD=least significant difference.

Table 4. *Mean agronomic performance of the genotypes at Werer, Bonta (Arage) and Miesso (1000seedwt).*

No	Treatment	Loc: Werer				Loc: Bonta (*Arage*)				Loc: Miesso				Over all Mean
		2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean	
1	Acc -00048	3.00	3.20	3.33	3.18	3.33	3.23	3.23	3.27	3.00	3.20	3.10	3.10	3.19
2	Acc -00001(1)	3.23	3.13	2.77	3.04	2.77	3.03	3.03	2.94	3.23	3.13	3.18	3.18	3.06
3	Acc -00002	2.97	2.97	2.57	2.83	2.57	3.10	3.10	2.92	2.97	2.97	2.97	2.97	2.91
4	Acc -00015	2.73	2.70	2.80	2.74	2.80	3.57	3.57	3.31	2.73	2.70	2.72	2.72	2.92
5	Acc -00033(1)	3.07	2.90	3.23	3.07	3.23	2.77	2.77	2.92	3.07	2.90	2.98	2.98	2.99
6	Acc -00032	3.40	3.27	3.50	3.39	3.50	3.63	3.63	3.59	3.40	3.27	3.33	3.33	3.44
7	Acc -00016(1)	3.07	3.17	2.83	3.02	2.83	3.27	3.27	3.12	3.07	3.17	3.12	3.12	3.09
8	Acc -00025	3.20	2.90	3.30	3.13	3.30	3.50	3.50	3.43	3.20	2.90	3.05	3.05	3.21
9	Acc -00044(2)	3.07	3.133	2.37	2.85	2.37	2.87	2.87	2.70	3.07	3.13	3.10	3.10	2.89
10	Acc -00049	2.73	2.63	2.27	2.54	2.27	2.70	2.70	2.56	2.73	2.63	2.68	2.68	2.59
11	Adi	3.30	3.10	3.37	3.25	3.37	3.43	3.43	3.41	3.30	3.10	3.20	3.20	3.29
12	Serkamo white	3.30	3.27	3.63	3.40	3.63	2.63	2.63	2.97	3.30	3.27	3.28	3.28	3.22
13	Acc -00024(1)	3.20	3.23	3.50	3.31	3.50	3.47	3.47	3.48	3.20	3.23	3.22	3.22	3.34
14	Acc -44(1)	2.77	2.77	2.77	2.77	2.77	3.57	3.57	3.30	2.77	2.77	2.77	2.77	2.94
15	Acc -00035	3.13	3.20	3.63	3.32	3.63	3.53	3.53	3.57	3.13	3.20	3.17	3.17	3.35
	Mean	3.08	3.04	3.06	3.06	3.06	3.22	3.22	3.16	3.08	3.04	3.06	3.06	3.094
	CV	3.40	4.19	5.71	7.22	5.71	3.25	3.25	8.26	3.4	4.19	2.47	3.48	7.93
	LSD	0.17	0.21	0.29	0.21	0.29	0.17	0.17	0.24	0.17	0.21	0.13	0.10	0.13

Where; Loc=location, CV=coefficient of variation and LSD=least significant difference.

Thousand seed weight: - analysis of variance revealed that 1000 seed weight differed significantly between genotypes. The weight of a thousand seed was recorded by Acc-00032 and Acc-00035; while, the lowest 1000 seed weight was recorded by Acc-00049 (Table 4). Similarly, 1000 seed weight and seed yield per hectare among sesame genotypes [9, 10].

Table 5. *Mean agronomic performance of the genotypes at Werer, Bonta (Arage) and Miesso (Pod/Plant).*

No	Treatment	Maturity Loc: Werer				Maturity Loc: Bonta (*Arage*)				Maturity Loc: Miesso				Over all mean
		2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean	
1	Acc -00048	40.67	37.87	41.67	40.07	57.27	80.93	117.07	85.09	76.00	26.33	27.33	43.22	56.13
2	Acc -00001(1)	46.33	31.60	42.67	40.20	40.93	53.67	112.60	69.07	64.67	39.67	22.00	42.11	50.46
3	Acc -00002	45.33	20.73	49.00	38.36	58.00	56.80	82.93	65.91	63.67	36.27	25.33	41.76	48.67
4	Acc -00015	48.33	31.93	43.33	41.20	55.73	58.53	110.60	74.96	54.00	29.43	24.67	36.03	50.73
5	Acc -00033(1)	45.33	27.67	49.33	40.78	58.33	68.73	91.93	73.00	59.33	35.97	23.33	39.54	51.11
6	Acc -00032	38.67	29.53	36.67	34.96	51.40	60.07	95.40	68.96	54.33	30.87	20.67	35.29	46.40
7	Acc -00016(1)	45.67	42.53	44.00	44.07	70.27	58.87	100.73	76.62	60.33	39.70	21.67	40.57	53.75
8	Acc -00025	55.33	36.47	35.33	42.38	65.73	71.87	80.73	72.78	53.67	25.30	21.33	33.43	49.53
9	Acc -00044(2)	50.33	34.47	41.33	42.04	52.80	52.33	132.27	79.13	64.33	31.80	25.33	40.49	53.89
10	Acc -00049	46.67	33.73	30.33	36.91	67.67	82.40	129.20	93.09	78.00	37.50	32.00	49.17	59.72
11	Adi	53.00	31.87	33.00	39.29	66.67	69.00	143.67	93.11	72.67	39.13	22.33	44.71	59.04
12	Serkamo white	55.67	37.40	33.67	42.24	75.87	63.80	108.07	82.58	81.00	33.93	27.00	47.31	57.38
13	Acc -00024(1)	39.33	43.33	36.00	39.56	57.40	46.20	93.73	65.78	74.00	38.53	21.67	44.73	50.02
14	Acc -44(1)	45.00	30.60	48.33	41.31	68.27	65.67	108.07	80.67	59.67	45.20	24.00	42.96	54.98
15	Acc -00035	59.33	29.20	29.00	39.18	65.67	67.00	56.53	63.07	64.00	37.53	21.67	41.07	47.77
	Mean	47.67	33.26	39.58	40.17	60.80	63.72	104.23	76.25	65.31	35.14	24.02	41.49	52.64
	CV	12.17	35.86	19.82	24.46	22.44	22.73	31.53	30.19	22.14	42.00	30.57	29.64	52.50
	LSD	9.70	19.95	13.12	9.17	22.82	24.23	54.97	21.49	24.18	24.69	12.28	11.48	14.79

Where; Loc=location, CV=coefficient of variation and LSD=least significant difference.

Pods per plant: The analysis of variance shown that genotypes differed significantly in pods per plant. As a result, the genotypes Acc-00048, Acc-00049, Serkamo white and Adi had the highest pods per plant; while, Acc-00002 had the smallest number of pods per plant. Similarly, seven genotypes out of fifteen sesame genotypes performed better than the overall mean (Table 5). Similarly, the number of pods per plant varied significantly between sesame genotypes [8, 9, 10].

Plant height and maturity date: in terms of plant height, the analysis of variance shown significant differences between genotypes. The tallest genotypes were Acc-44(1) and Acc-00049, while the shortest genotype was Acc-00032 (Table 6). Significant variation in sesame genotypes on plant height stated [10]. Maturity date: Significant variation was observed among sesame genotypes; the longest plant height were Acc-44(1) and Acc-00049; while, those with the shortest maturity date were Adi, Acc-00035, and Acc-00032 (Table 7).

Table 6. *Mean agronomic performance of the genotypes at Werer, Bonta (Arage) and Miesso (Plant Height).*

No	Treatment	Loc: Werer				Loc: Bonta (*Arage*)				Loc: Miesso				Over all mean
		2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean	
1	Acc -00048	119	113	109	114	106	169	139	138	121	102	79	101	119
2	Acc -00001(1)	134	111	117	121	136	170	158	158	124	103	83	104	127
3	Acc -00002	127	88	112	109	146	180	167	164	123	108	79	103	125
4	Acc -00015	141	130	122	131	155	125	134	138	138	103	90	111	126
5	Acc -00033(1)	118	97	115	110	93	189	171	151	109	95	74	92	118
6	Acc -00032	107	86	99	97	97	142	145	128	102	101	68	90	105
7	Acc -00016(1)	126	115	110	117	133	186	126	149	121	101	79	100	122
8	Acc -00025	118	103	99	107	117	157	126	133	95	94	72	87	109
9	Acc -00044(2)	157	133	118	136	153	193	172	173	138	99	90	109	139
10	Acc -00049	144	113	111	123	147	198	185	176	148	102	81	110	137
11	Adi	131	105	112	116	133	185	147	155	119	110	81	103	125
12	Serkamo white	129	115	98	114	145	188	190	174	120	102	77	100	129
13	Acc -00024(1)	136	129	122	129	148	147	144	146	134	110	86	110	128
14	Acc -44(1)	147	124	128	133	150	176	144	157	136	105	86	109	133
15	Acc -00035	124	100	101	109	118	184	130	144	112	112	83	102	118
	Mean	130	111	112	118	132	173	152	152	123	103	80.5	102	124
	CV	5.6	13.7	9.2	9.87	8.75	6.68	8.61	12.2	7.42	14.1	8.26	11.1	16.4
	LSD	12.1	25.3	16.9	10.8	19.3	19.4	21.9	17.4	15.2	24.4	11.1	10.6	10.9

Where; Loc=location, CV=coefficient of variation and LSD=least significant difference.

Table 7. *Mean agronomic performance of the genotypes at Werer, Bonta (Arage) and Miesso (Maturity).*

No	Treatment	Loc: Werer				Loc: Bonta (*Arage*)				Loc: Miesso				Over all mean
		2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean	
1	Acc -00048	120.0	95.33	110.00	108.44	95.33	110.00	110.33	105.22	107.67	102.67	110.17	106.83	106.70
2	Acc -00001(1)	120.0	96.67	110.67	109.11	96.67	110.67	113.00	106.78	108.33	103.67	111.83	107.94	107.94
3	Acc -00002	123.33	109.00	118.67	117.00	109.00	118.67	110.33	112.67	116.17	113.83	114.50	114.83	114.83
4	Acc -00015	128.33	108.00	109.00	115.11	108.00	109.00	107.00	108.00	118.17	108.50	108.00	111.56	111.56
5	Acc -00033(1)	120.00	94.00	117.00	110.33	94.00	117.00	112.67	107.89	107.00	105.50	114.83	109.11	109.11
6	Acc -00032	120.00	94.00	108.33	107.44	94.00	108.33	107.00	103.11	107.00	101.17	107.67	105.28	105.28
7	Acc -00016(1)	123.33	104.67	118.00	115.33	104.67	118.00	114.67	112.44	114.00	111.33	116.33	113.89	113.89
8	Acc -00025	120.00	95.00	108.33	107.78	95.00	108.33	107.00	103.44	107.50	101.67	107.67	105.61	105.61
9	Acc -00044(2)	128.33	106.33	120.67	118.44	106.33	120.67	115.33	114.11	117.33	113.50	118.00	116.28	116.28
10	Acc -00049	130.00	106.33	121.33	119.22	106.33	121.33	118.67	115.44	118.17	113.83	120.00	117.33	117.33
11	Adi	121.67	93.33	108.33	107.78	93.33	108.33	111.00	104.22	107.50	100.83	109.67	106.00	106.00
12	Serkamo white	120.00	94.67	114.33	109.67	94.67	114.33	119.00	109.33	107.33	104.50	116.67	109.50	109.50
13	Acc -00024(1)	123.33	94.67	107.00	108.33	94.67	107.00	108.33	103.33	109.00	100.83	107.67	105.83	105.83
14	Acc -44(1)	128.33	109.67	107.00	115.00	109.67	107.00	112.00	109.56	119.00	108.33	109.50	112.28	112.28
15	Acc-00035	120.00	97.00	107.00	108.00	97.00	107.00	107.67	103.89	108.50	102.00	107.33	105.94	105.94
	Mean	123.11	99.91	112.38	111.80	99.91	112.38	111.60	107.96	111.51	106.14	111.99	109.88	109.88
	CV	1.93	3.20	2.68	3.61	3.20	2.68	3.13	4.24	1.88	2.31	1.74	2.77	6.62
	LSD	3.98	5.35	5.03	3.80	5.35	5.03	5.84	4.27	3.51	4.09	3.27	2.84	3.90

Where; Loc=location, CV=coefficient of variation and LSD=least significant difference.

3.2. GGEbiplot Analysis of Sesame Genotypes Tested at Different Location over Season

3.2.1. Which-Won-Where

One of the most interesting characteristics of a GGEbiplot is its ability to display which-won-where pattern of a genotype by environment dataset (Figure 2). This application of a biplot is appealing to many researchers because it graphically addresses important concepts such as crossover GE, mega-environment differentiation, specific adaptation, and so on. A polygon is first drawn on genotypes farthest away from the biplot origin, so that all other genotypes are contained within the polygon [11]. As a result, genotype twelve (G12) is located on the vertex of the polygon in the first quadrant, which is suitable in environment (E1, E4 and E7); as a result, this is Werer site in 2014, 2015, and 2016; and also E5 is Bonta (*Arage*) in 2014; while genotype fourteen (G14) is located on the vertex of the polygon in the fourth quadrant, which is suitable in specific environment and suitable genotype for environment (E3 and E9) that is Miesso site in 2014 and 2016 (Figure 2 and Table 2).

3.2.2. Ranking of Genotypes in GGEbiplot Analysis Based on Mean Performances

The genotype (G13 and G12) outperformed the genotypes in terms of mean performance. Genotype 12 performed best in environments E1, E4, E7 and E5, whereas G14 performed best in environments E3 and E9. Environment one (E1) is the best ideal sesame growing environment, followed by E4, E5 and E7 (Figure 3). Thus, GGbiplot analysis of G and GE interaction explained 74.32 percent of the variation (Figures 2, 3 and 4).

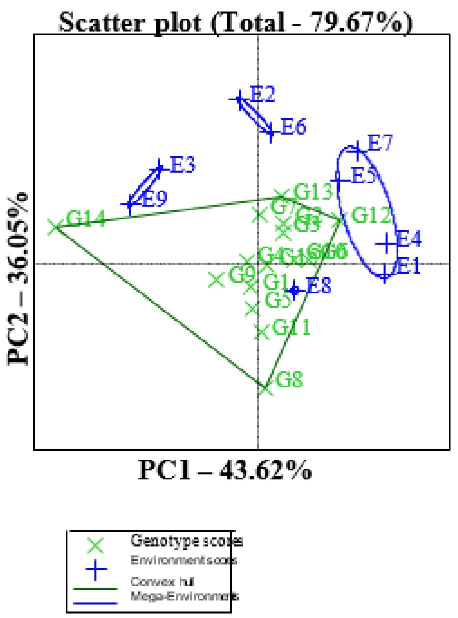

Figure 2. The which-won-where view of the GGE biplot.

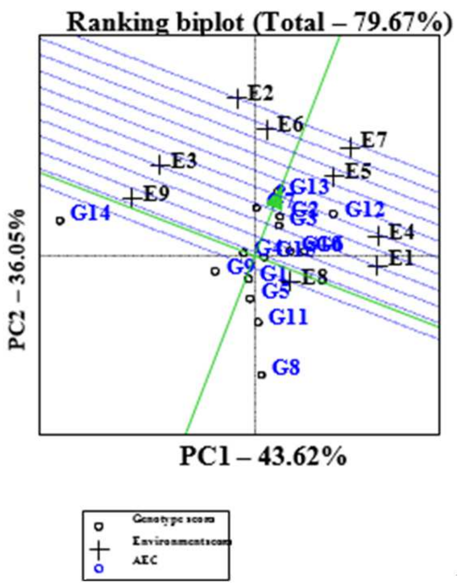

Figure 3. *Ranking genotype and environment relative their mean performance.*

3.2.3. Ranking Genotypes Relative to the Ideal Genotype

An ideal genotype should have both high mean performance and high stability across environments [11]. Figure 3 defines an "ideal" genotype (the center of the concentric circles) to be a point on the averaged environment axis EA ("absolutely stable") in the positive direction and has a vector length equal to the longest vectors of the genotypes on the positive side of average environment axis (AEA) is maximum mean performance. Therefore, genotypes located closer to the 'ideal genotype' are more desirable than others. Thus, G13 and G12 were more desirable than the others Figure (Figures 2, 3 and 4). "Stable" genotypes are desirable if only when they have high mean performances [11-13]; therefore, G12 have the highest mean performance and stable genotype what call Serkamo white.

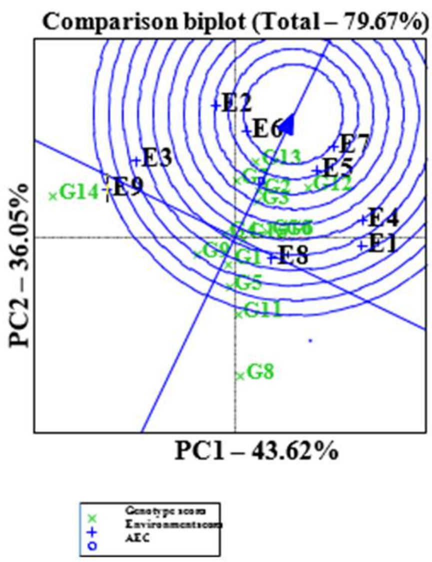

Figure 4. *The Environment vector view of GGE biplot show similarity among test environments in discriminating the genotypes.*

4. Conclusion

Sesame is a source of oil, food and a cash crop. Seed yield of sesame in Ethiopia is very low due to lack of high yielder improved sesame variety/ies. Hence, the objectives of this research were to evaluate the performance of sesame genotypes and GGEbiplot analysis. Fifteen sesame genotypes including check (Adi) were tested in randomized complete block design with three replications; used during the main cropping season (2014, 2015 and 2016) at three sesame growing locations: Werer, Bonta (*Arage*), and Miesso. Genotype Serkamo white (G12) and Acc-44(1) (G14) outperformed the other genotypes. Hence, the main advantages over the other tested genotypes were its higher grain yield and white seeded color. Serkamo white (G12), have the highest mean performance and stable genotype. Furthermore, because of the high seed yield, stability and white seed color, Serkamo white genotype (G12) is expected to a command high external market preferences and prices, contributing to the future sesame export market.

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