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Evaluating Yield and Yield Related Performance of Drought and Striga Tolerant Sorghum Genotypes in Northwestern Tigray

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Sorghum (Sorghum *bicolor L*) is the fourth most important cereal crop worldwide and occupies the second position among the staple food grains in semi-arid tropics. The adaptation of grain sorghum to a wide range of environmental conditions has led to the evolution and existence of extensive genetic variation for drought and striga tolerance. The crop requires relatively less water than other important cereals such as maize and wheat. However, yield potential of the crop is significantly limited due to major constraints of drought and striga infestations and those affect sorghum production worldwide and continue to be a challenge to plant breeders, despite many decades of research. Drought impairs normal growth, disturbs water relations, reduces water use efficiency and affects yield. Underestimating the different mechanisms underlying drought tolerance is vital for the breeding to alleviate adverse effects of drought in order to boost productivity. A field experiment with twenty nine striga and drought tolerant genotypes by three replications using randomized complete block design was conducted at Tahtay adiabo and Tselemti districts to evaluate the drought and striga tolerance traits in addition to performance of yield and major yield related traits. Tolerant genotypes can therefore be used to improve yield and crop performance hence alleviating food insecurity, poverty and famine among smallholder farmers. Hence, finally with considering the overall phenotypic performance (acceptability), stay greenness trait (1-5 scale scoring), striga infestation (with relating tolerant traits) genotype 38 with mean grain yield of 40.8 qt/ha and genotype 9(33. 8 qt/ha) were selected and promoted to variety verification trial with including highly striga infested and drought prone testing sites using recently released comparable standard checks.

Key words*:* Drought, Striga, Sorghum, Grain yield

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INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench): is an important cereal crop used by humans as staple food grain in many semi-arid and tropical areas of the world (Belay, 2017). It is the fourth most important cereal crop globally following wheat, rice and maize. It is a staple food for more than 500 million people in the semi-arid tropics of Africa and Asia and more than 80% of the world area of production is confined to these two continents (Masresha *et al.*, 2011). In Ethiopia, it is known as strategic and staple crop. According to (CSA, 2017), it ranks third after maize and tef in total production, after maize in yield per hectare and after tef and maize in area harvested. The crop requires relatively less water than other important cereals such as maize and wheat. However, yield potential of the crop is significantly limited due to drought and heat stresses within the tropics and subtropics necessitating sorghum breeding for drought tolerance and productivity (Blum, 2005).

Based on report of CSA (2017) productivity of sorghum in Ethiopia reached 25.25 qt ha^{-1} but still far below to the global average and the crop yield potential with figure of 2.5, 3.2 and 8.0 t ha-1 respectively due to the following major factors: Drought, striga, insect pest, soil fertility decline, inadequate adoption of existing improved varieties and improper post harvest management practices.

Drought is perhaps the most prevalent abiotic stress affecting plant growth, survival and productivity in the world (Bohnet and Jensen, 1996). Drought is most environmental stress and it can follow total yield loss (failure).The effects of drought stress on grain yield depend on the growth & dev't stage of the crop (i.e booting to grain filing) in which the water deficit occurs.

Growing crops that withstand moisture stress have been particularly considered as the most effective method to enhance crop production under suboptimal moisture conditions (Tunistra *et al.*, 1996).Drought tolerance is a phenotypic expression of a number of morphological and physiological mechanisms, including drought escape, dehydration avoidance and dehydration tolerance (Levitt, 1972; Ludlow, 1993).

Striga: is a major sorghum production constraint by its allelopathy, competition for nutrients and limiting the expression of the full genetic potential of sorghum plants. In Ethiopia, losses of 65-100% are common in heavily infested fields (Ejeta *et a*l., 2002). So, best strategy is to incorporate different tolerance/resistance genes to both major stresses into the same genotype is possible. For drought, incorporate drought tolerance and stay greenes traits from known source like B35 and S35 Ethiopian sorghum materials (lines) in addition to stress escaping mechanism (earliness) and for Striga, incorporate striga tolerant/resistant genes from internationally known source like Framida and SRN-39 ICRISAT materials (lines).

Based on the practical problem of striga and drought tolerant improved sorghum in the mandate areas, Shire-Maitsebri Agricultural Research Center has been conducting multi environment trial with the following objective

OBJECTIVE OF THE STUDY

❖ To evaluate drought and striga tolerant and high yielding sorghum genotypes in North western Tigray region, North Ethiopia

MATERIALS AND METHODS

Experimental Treatment and Design

A field experiment was carried out for two successive seasons (2015/16 and 2016/17) for two years (i.e four environments of location – year combination) at Tahtay adiabo and Tselemti districts. The experimental site is situated at an altitude of 1006 m.a.s.l, 14024'00" N, 37056'00" E with annual mean rainfall of 683 mm for Sheraro and altitude of 1360 masl, $13^0$05' North Latitude and $38^0$08' East Longitude, 929mm mean annual rainfall for Maiayni respectively. The areas are characterized by hot to warm semi-arid low land plains, with a mono-modal rainfall pattern between May and September. The experimental material consisted of twenty seven (coded from genotype1 to genotype 27) which incorporate striga and drought tolerant traits with ICRISAT origin genotypes with including one local and standard checks were used and those genotypes selected from the previously done national variety trial. The experiment was arranged in a randomized complete black design with three replications, plot size of 2.55m x 5 m (11.25 m2) used. The blocks also separated by 1.5m, where as plots within a block are 0.75m apart from each other. Each plot consists of 3 rows of 5m length. The promising sorghum genotypes were evaluated for various droughts, striga, agronomic and morphological characteristics. All plots were fertilized uniformly with 100 kg/ha Urea and 100 kg/ha Diammonium Phosphate (DAP). Full dose of P and half of N was applied at the time of planting and the remaining half dose also applied side dressed at knee height stage of the crop. All other cultural practices were applied uniformly to all plots as per standard recommendations for the crop.

Data collected

- **Days to 75% physiological maturity:** The time from the date of planting until the grains from the main shoot reached to the black layer stage. Days to physiological maturity was recorded at 75%maturity.
- **Plant height (cm):** Plant height was measured from five randomly taken plants from middle rows at maturity from the ground level to the base of the panicle.
- **Thousands kernel weight (g):** This was record from sample taken from the net plot area often yield was taken. Prior to measuring the weight the kernel was adjusted to 12.5% moisture level. The kernel was counted using electronic seed counter and the weight was determined using sensitive balance**.**
- **Biomass weight (g):** Above ground dry biomass

weight was determined at harvesting time from the plants taken from the net plot. **Grain yield (kg):** All plants of net plot area were harvested to determine grain yield per plot and the yield was converted to per hectare bases and adjusted to 12.5% moisture level.

- **Stay-green** scores at maturity based on visual ratings (Wanous, Miller, & Rosenow, 1991) using 1 to 5 scale (1 = < 10% leaves stay-green and 5 = >75% leaves stay-green and most desirable)
- **Striga count:** Striga population per plot was count from the central infested plots at the time sorghum flowering and maturity.

Statistical Data Analysis

All the collected data were subjected to analysis of variance using Genstat Software (18th edition) to see variations between sorghum genotypes. The genotypes means were separated using the least significant differences (LSD) test at 5% level of significance.

RESULT AND DISCUSSION

The combined analysis of variance across locations and years showed highly significant differences at ($p \leq 0.05$) among locations (L) and genotypes (G), Year (Y) and their interaction for plant height and biomass yield but not significant in their interaction (G x L x Y) for days to maturity, 1000 kernels weight and striga count, grain yield traits (Table 1).

Days to 75% physiological maturity

Early maturity was regarded as of high importance by farmers in the study given the low amount of rainfall received in sorghum growing areas and the erratic nature of rainfall. Based on the combined anova the studied genotypes showed significant difference for days to 75% physiological maturity at ($p \leq 0.05$) among the genotypes, locations and years but not significant their interaction (Table 1). The LSD test showed that, all genotypes were significantly different with each other and this indicating there is diversity among each other. The farmer's variety (local check) had higher number of days to 75% physiological maturity with the mean value of 119 days, while genotype **1** recorded significantly lower days than the rest with the mean value of 108 days for 75% maturity respectively. Similar results for significant effect due to variety × location (interaction effect) is reported by Ezzat *et al.* (2010), for days to 50% flowering, plant height, 1000 grain weight and grain yield. According the report of Farshadfar and Hasheminasab, 2013) drought is one of the major environmental challenges in crop productions to worldwide today and this can be mitigate using shifting to early maturing (drought escaping) genotypes.

Grain yield per hectar (kg ha^{-1})

Based on combined analysis of variance, a significant difference was observed in mean grain yield per hectare of the studied genotypes at the given locations and years but there is no significance difference in their interaction (genotype x location x year) at ($p \leq 0.05$). This indicated there consistence of genotype performance across the targeting genotypes with low effect of environment on the genotypes. Hence, Genotype 38 registered the maximum grain yield (4077.6 kg ha-^{1}) followed by genotype 9 (3384.5 kg ha-^{1}), while the lower grain yield was recorded in genotype 40 (1809 kg ha-1) followed by genotype 48 (1915 kg ha-1). Genotype 38 had comparable performance interms of yield components like biomass yield, plant height and kernel weight. So, from the current finding, Genotype 38 and Genotype 9 were displayed 49.5%, 32.49% yield advantage over standard check Gobiye respectively. Hopefully, these outstanding candidate were submitted as candidate genotypes for variety verification trial to be evaluated by variety verification committee and to be released for commercial production purpose in the 2019/20 cropping season.

Biomass yield per hectar (kg ha^{-1})

From table 1 the combined analysis of variance (ANOVA) showed that highly significant ($P \leq 0.05$) difference was recorded between genotype (G), location (L) and their interaction, genotype by location interaction (GLI). Furthermore, the highly significant values for the interaction between location and year indicated that inconsistent environmental conditions prevailed across locations and across years. All these contributed to the existence of G x E interaction, where genotypes showed fluctuations in their response to different environments. In addition, the significant interactions showed the existence of unstable genotypes. So, since sorghum is mainly used for food and fodder (dual-purpose crop) in the study area genotype /s with high grain yield and above ground biomass yield is high preferable. Biomass yield of 13.8 t/ha was again obtained in genotype 38 while the least obtained in genotype 48 (7.5 t/ha) for perhaps same reason for the grain yield.

Contrarily with this study, height of the plant, non senescence trait, days to maturity have direct effect on biomass production (Habyarimana *et al.*, 2004).Therefore, the genotypes 38 relatively good in both major traits and needs to be multiplied and distributed in the testing areas.

Table 1 Combined mean performance of the 29 genotypes across environment

SN	Genotype	Grain Yield in kg/ha							Biomass Yield in kg/ha						Combined Mean
		2015	2016	2015	2016	2015	2016	Combined Mean	2015	2016	2015	2016	2015	2016	
		Sheraro		Maiayni		Gemhalo			Sheraro		Maiyani		Gemhalo		
1	1	3434.1	2873.5	2325.9	1911.1	3557.6	1239.3	2556.9	16195.6	15178.7	7448.1	4413	12073.2	3194.8	9750.6
2	12	3312.6	3456.6	3688.9	2201.9	3699.3	1807.8	3027.8	18912.6	20505.5	10470.4	5146.3	17497.1	5170.7	12950.4
3	16	3712.6	3394.1	2881.5	2090.7	3318.4	1583	2830	18971.9	16973.3	8096.3	5038.9	17553.7	4890.4	11920.7
4	2	2983.7	2594.7	2888.9	1459.3	3128.4	1466.3	2420.2	8960	12742.8	11044.4	3653.7	13926.3	3770	9016.2
5	20	2936.3	3847.7	3781.5	1927.8	3392.4	1708.1	2932.3	11448.9	16061	11474.1	4498.1	13990.3	4334.1	10301.1
6	21	4444.4	3064.3	3900	2309.3	2883.3	1862.2	3077.3	15360	14640.6	13663	5874.1	12547.9	6203	11381.4
7	22	3739.3	3583.4	3751.9	2777.8	2657.8	1416.7	2987.8	15585.2	15601.2	10437	6740.7	18389	6387	12190
8	27	3608.9	3692.7	4088.9	1611.1	3051.6	1470.4	2920.6	14189.6	15716.4	12522.2	3890.7	16716.1	4122.2	11192.9
9	28	3200	3220.1	3925.9	1300	2737.1	1721.1	2684.1	12065.2	14058.7	9277.8	3042.6	14268.3	3921.1	9438.9
10	32	3837	3084.7	3448.1	1500	2458.2	2082.2	2735.1	15283	15789.9	11014.8	3766.7	11389.4	5571.1	10469.1
11	33	3757	3577.5	3518.5	2244.4	3671.3	1885.2	3109	18992.6	14928.6	11759.3	5650	19535.9	5629.6	12749.3
12	35	3440	3410.7	3611.1	2350	3028.7	1688.1	2921.4	22634.1	19467	8425.9	6124.1	17693.3	5365.9	13285
13	36	3864.4	4243.7	4303.7	3092.6	4366.3	2857.4	3788	14755.6	16610.4	11692.6	5288.9	12364.1	6472.2	11197.3
14	38	4245.9	4697.6	4537	3142.6	5158.4	2684.1	4077.6	17875.6	19880.6	12481.5	6361.1	19122.9	7128.5	13808.4
15	39	3161.5	2521.8	2581.5	1390.7	2878.9	1716.7	2375.2	15697.8	13449.2	6763	3627.8	14743.4	4053.7	9722.5
16	4	3040	3717	3992.6	2181.5	3043.4	1639.3	2935.6	17878.5	19320	13111.1	5675.9	17374.6	4939.3	13049.9
17	40	1460.7	2661	2022.2	1387	1770.7	1552.2	1809	6835.6	14139.6	5955.6	3305.6	8701.9	4841.1	7296.5
18	41	2960	2797.3	2696.3	1429.6	3650.9	1421.6	2492.6	12177.8	13244.7	5496.3	3435.2	15382.1	2871.6	8768
19	42	3588.1	3797.9	2581.5	1453.7	3336.5	1819.3	2762.8	16234.1	16426.1	7581.5	3720.4	18467.7	3926.7	11059.4

Table 1. Cont'd

SN	Genotype	Grain Yield in kg/ha							Biomass Yield in kg/ha						Combine Mean
		2015	2016	2015	2016	2015	2016	Combin Mean	2015	2016	2015	2016	2015	2016	
		Sheraro		Maniani		Gemhalo			Sheraro		Maniani		Gemhalo		
20	45	3401.5	3269.9	3103.7	2679.6	3104.7	1380.4	2823.3	21517	17038.8	10325.9	6253.7	17902.5	5161.9	13033.3
21	47	3072.6	3340.4	1888.9	1435.2	3092.2	1457.4	2381.1	11520	14893	5400	3816.7	12556.7	4490.7	8779.5
22	48	2417.8	3191.7	1366.7	1394.4	1972.9	1148.9	1915.4	9834.1	13428.7	4481.5	3524.1	7804	3252.6	7054.2
23	49	3147.7	1959.4	3140.7	1625.9	1969.6	1297.8	2190.2	9647.4	12732.7	10066.7	3837	7900.8	4983	8194.6
24	5	3774.8	4251	4007.4	1498.1	2505.1	2193.3	3038.3	21736.3	20215.4	13763	3627.8	10969.7	7467.4	12963.3
25	50	3967.4	3224.3	2211.1	975.9	3537.6	1610.7	2587.8	15232.6	12942.8	8270.4	2440.7	14363.7	3781.1	9505.2
26	7	3893.3	3976.6	3514.8	2403.7	3288.9	1857	3155.7	20173.9	20607.7	11051.9	5753.7	19886.7	5197.8	13778.6
27	9	3961.5	4579.3	3725.9	2407.4	3576.1	2056.7	3384.5	21040	19376.3	12100	5835.2	13907.3	5449.3	12951.3
28	Gobiye	2573.3	2992.6	2261.1	1085.2	2013.9	1432.2	2059.7	9114.1	12915	5388.9	2525.9	8145.1	5628.5	7286.3
29	local	3268.1	1734.2	3177.8	496.3	3408.3	1851.9	2322.8	18743.7	12747.6	11007.4	1446.3	16606.2	6037	11098
	Mean							2769							10834.2
LSD(< 0.05)	Gene							430.1**							1672.98**
	Env't							138.3**							538.1**
	Year							112.9**							439.4**
	Gene* Loc							744.9*							2897.7**
	Gene* Year							608.2*							2365.95**
	Loc* Year							195.6**							760.97**
	Gene* Loc*year							1053.4ns							4097.94**
CV	Genotype							23.7							23.6

Table 1. Cont'd

SN	Genotype	Days to 75% physiological Maturity							Plant Height(cm)						Combine Mean
		2015	2016	2015	2016	2015	2016	Combi Mean	2015	2016	2015	2016	2015	2016	
		Sheraro		Maiayni		Gemhalo			Sheraro		Maiayni		Gemhalo		
1	1	106.7	101.3	120.7	106.7	115	85.7	106	243.1	213.3	190.4	170.1	184.9	109.1	185.1
2	12	110.7	108	122.3	111	116.3	85.7	109	249.6	231.1	199.5	178.7	303.3	128	215
3	16	105.7	106	124.3	108.3	112.3	87.7	107.4	268.2	255	188.3	169.2	205.6	149.3	205.9
4	2	114	109.3	122	120.3	122	86	112.3	176	188.6	194.7	145.2	160.1	95.7	160.1
5	20	110	105.3	123	109	118	94	109.9	208.5	211.1	196.1	153.1	188.9	142.2	183.3
6	21	112	107.7	122.7	109.7	119.3	84	109.2	150.5	149.9	165	130.5	151.1	103.9	141.8
7	22	110.7	107	124	110	113	94.7	109.9	177.1	166.9	170	131.5	176.7	104	154.4
8	27	110	105	123.7	108	119.3	86.3	108.7	197.8	229.4	173.4	159.1	178.7	119.7	176.4
9	28	113	108	126	119	122.3	90	113.1	179.7	195	186.9	146.8	169.3	124	167
10	32	111	104.7	125.7	112	115.7	74.3	107.2	227.1	220.5	193.6	159.2	182.8	136.1	186.5
11	33	109.7	107.3	122	109.3	117	100.3	110.9	260.3	222.8	186.3	159.9	237.1	127.1	198.9
12	35	111	106.3	121.7	111.7	115.7	98.7	110.8	246.3	232.9	193.5	170.7	203.4	122.5	194.9
13	36	111.7	107.3	125	115.3	115.3	92	111.1	221.6	251.4	198.7	169.1	165.9	140.2	191.1
14	38	111	108	122.7	118	117	100.3	112.8	294.5	266.9	211.4	165.4	196.6	142.7	212.9
15	39	107	104	123	117.7	122	88.3	110.3	263.4	226	200.5	142.4	203.8	112.1	191.4
16	4	111	107.3	124	112.7	113	88.7	109.4	221.3	217.1	183.1	158.6	196.3	126.5	183.8
17	40	111.7	104.7	123.3	116	121.7	86.7	110.7	139.1	148.8	143.4	139.8	140.7	115.1	137.8
18	41	107.3	102	126.3	116.7	122.3	87	110.3	183.5	161.7	140.1	116.3	164.5	80.3	141.1

Table 1. Cont'd

SN	Genotype	Days to 75% physiological Maturity							Plant Height(cm)						Combine Mean
		2015	2016	2015	2016	2015	2016	Combi	2015	2016	2015	2016	2015	2016	
		Sheraro		Maniani		Gemhalo		Mean	Sheraro		Maniani		Gemhalo		
19	42	110.7	106.3	120.3	113.3	121.3	93.3	110.9	214.4	210.2	171.5	149.2	206.5	119.8	178.6
20	45	106	106	121	121.7	115	94.7	110.7	244.6	237.3	190.2	187.1	175.8	130.1	194.2
21	47	105.3	103.7	122.3	112.3	111	86	106.8	169.1	139.5	144.3	126.2	146	98.2	137.2
22	48	107	102	118	117.3	120.3	90.3	109.2	145.1	148	127.5	129	129.2	98.7	129.6
23	49	110	111	123.7	122.3	112	101.7	113.4	136	222.1	201.7	161.7	105.9	154.9	163.7
24	5	108.7	105.7	123	113	118.3	95	110.6	245.7	226	191.1	159.9	172.6	118.1	185.6
25	50	110.3	108.3	125.3	112.3	113.7	85.7	109.3	238.5	204	158.5	145.4	167	133.2	174.4
26	7	109.3	107.7	123	114.3	110.7	95.3	110.1	275.1	253.4	197.8	177.4	204.1	147.9	209.3
27	9	110	107	122	117.7	116	87	109.9	244	245.1	192.1	163.1	172	131.9	191.4
28	Gobiye	109.7	106	118.5	117	114	88	108.9	149.5	142.9	138.1	134.7	114.5	102.4	130.3
29	local	113.7	108	126.3	130.3	116.3	88.7	113.9	307.5	311.4	175.3	249.8	245.2	172.5	243.6
	Mean							110.1							178.1
LSD(<0. 05)	Gene							3.65**							16.84**
	Env't							1.17**							5.42**
	Year							0.96**							4.42**
	Gene* loc							6.32ns							29.17**
	Gene* Year							5.16**							23.82**
	Loc* Year							1.66**							7.66**
	Gene* Loc*year							8.94ns							41.25*
CV	Genotype							5.1							14.4

Table 1. Cont'd

		1000 Seeds Weight(g)							Striga count at harvesting				
SN	Genotype	2015	2016	2015	2016	2015	2016	Combine Mean	2015	2016	2015	2016	Combine Mean
		Sheraro		Maiayni		Gemhalo			Sheraro		Maiayni		
1	1	29	32.33	29.67	21.87	29.5	29	28.56	11.67	7.33	40.67	23.7	20.83
2	12	32	34.33	31	22.6	28.83	27.33	29.35	13.67	7	44	7.33	18
3	16	28	38.33	28	19.67	31.5	28	28.92	18	0.67	36	10.7	16.33
4	2	28.67	33	29.67	23	30.67	26.33	28.56	12	0.67	55.33	7.67	18.92
5	20	24	35	29	23.93	25	27.67	27.43	15.33	4.67	34.67	20.3	18.75
6	21	19	30	23.67	18.5	25.33	22.67	23.19	6.33	2.33	24.33	5	9.5
7	22	24.33	28.67	31.33	16.13	26.5	25	25.33	9.67	5.33	20	7.33	10.58
8	27	27.33	31	29	22.07	30.17	26	27.59	12	2	33	8.33	13.83
9	28	24	29	27	20.33	28.17	28.5	26.17	9.67	5	23.33	29.7	16.92
10	32	27.67	31.67	28.33	23.07	27.67	31.33	28.29	13	3.33	19.33	21.3	14.25
11	33	28	29.33	26.67	21.8	27.5	28.33	26.94	26	2	23.33	22	18.33
12	35	29.33	35	28	24.67	28.17	28.33	28.92	8.33	2	31.33	33.3	18.75
13	36	27	42.67	30	20.53	25.33	23.33	28.14	5.33	1.33	44.33	4.67	13.92
14	38	30.33	31	34.67	19.13	28.33	26	28.24	16.67	3	43.33	12.3	18.83
15	39	25.67	35.33	36	24.27	33	30.67	30.82	27.67	3	25	17	18.17
16	4	28.33	32.33	32	20.93	29.67	25.33	28.1	9.33	3.67	22	20	13.75
17	40	30	36.67	28	27.93	27.33	27.33	29.54	6.67	4.33	15	25.7	12.92
18	41	22.33	38.67	30.67	26.4	27	34.5	29.93	16	4	39	21	20
19	42	29.33	34.67	32	20.13	30.5	26	28.77	13.67	4.33	13.33	12	10.83

Table 1. Cont'd

SN	Genotype	1000 Seeds Weight(g)						Combine Mean	Striga count at harvesting				Combine Mean
		2015	2016	2015	2016	2015	2016		2015	2016	2015	2016	
		Sheraro		Maniani		Gemhalo			Sheraro		Maniani		
20	45	26.33	36	32	23.87	32.67	28	29.81	24	1	27.33	17.7	17.5
21	47	24.33	33	30.67	26.27	26.17	25.67	27.68	15	4.67	15	16.7	12.83
22	48	22.67	33	21	23.4	28.17	25.33	25.59	22.67	3	25	8.67	14.83
23	49	24.33	29	33.33	25.93	26.83	29	28.07	24.67	4.67	50	10.3	22.42
24	5	29	40.4	29	27.27	27.33	31.67	30.78	19.33	5.67	22	7.33	13.58
25	50	24.33	33.67	27.67	28.4	27.5	27.33	28.15	19.33	5.33	21.67	10.3	14.17
26	7	26	33.33	25.67	22.27	26	26.33	26.6	15.67	5.33	54	17.3	23.08
27	9	32	38	32.67	27.8	26.67	27.67	30.8	25	2.67	88	7	30.67
28	Gobiye	25.67	30.33	31.67	23.13	28.33	24	27.19	15	2.33	23	17.7	14.5
29	Local	30.33	35.67	30.67	26.2	29.33	26.93	29.86	29.67	3.67	63	13.7	27.5
	Mean							28.18					17.05
LSD (<0.05)	Gene							2.61**					13.7ns
	Env't							0.839**					3.5**
	Year							0.685ns					3.5**
	Gene* loc							4.52ns					19.3ns
	Gene* Year							3.691**					19.3ns
	loc* Year							1.187**					5.1ns
	Gene* loc*year							6.393ns					27.3ns
CV	Genotype							14.1					99.7ns

Thousand Seed weight

Significant differences on thousand seeds weight were observed among genotypes, locations and years at (P≤0.05) while interaction effects (G x L x Y) were not significant at (P≤0.05). Genotype 5(31.67 g) followed by genotype 39 (30.82) respectively while genotype 21(23.2g) scored lowest thousand seeds weight. Thousand seed weight is an important yield determining component and reported to be a genetic character that is influenced least by environmental factors (Ashraf *et al*, 1999).

Plant height (cm):

There were highly significant differences among sorghum genotypes and checks across the locations and years at (p≤0.05) (Table 1). The highest plant height was scored obtained in local check variety (243.6cm) followed by genotype 7(209.3 cm) whereas Gobiye also scored (standard check) low plant stature (130.3 cm). In line with this many researchers have shown highly significant variability in plant height in various maize genotypes (Nazir *et al*., 2010; Iqbal, *et al*., 2010a). Also the result correspond with Amare, *et al* (2015) who found plant height had positive direct effect through analysis of sixteen sorghum varieties planted in two locations. Plant height is not only important for breeding of new genotypes of sorghum, for green and dry matter production, but also for grain yield. Ear height has also been described to be one of the most important selection criteria in most breeding programmes especially the root and stock lodging (Olawuyi *et al*., 2013). Lower plant and ear height augments plant lodging resistance in maize with increase grain yield (Esechie *et al*., 2004). While high vertical root-pulling resistance (lodging resistance) took up more N and utilized it more efficiently, better agronomic performance and higher yield resulted (Kamara *et al*., 2003; iu and Wiatrak, 2011). Hence, shorter commercial varieties are often preferable for mechanized agriculture compared to the local cultivars grown by subsistence farmers.

Striga Counting

Striga population count per plot: The analysis of variance indicated that there was no significant (P≤0.05) difference due to genotype and environment interaction for number of striga plant population at harvesting. Data collected Striga were counted twice at time of flowering and maturity. **21** (9.5 striga population), genotype **22** (10.58) gave lower striga reaction score and produced higher grain yield than local check in both years while high striga plant population per plot were appeared with genotype of 9 (30.7), local check (27.5) and genotype 7 (23.1) respectively. Genotype 42 supported more number of *Striga* plants than other genotypes and checks. As Mohamed *et al* 2016 reported a high infestation of Striga population cause significant losses in sorghum biomass and grain yield occur in sub Saharan Africa. Therefore, development of high yielding sorghum varieties which can resist Striga and show good biomass yield will enhance farmers' preference to improved lowland sorghum varieties at the testing districts.

CONCLUSION AND RECOMMENDATION

Sorghum is the major staple crop cultivated widely in the drought prone lowland areas of Ethiopia where *Striga* is prevalent. Drought and *Striga* are the major abiotic and biotic constraints to sorghum production in sub-Saharan Africa particularly in Ethiopia. In order to develop a sustainable Striga control and drought mitigation options and reduce their effect on the crop there is a need to evaluate sorghum genotypes introduced from international research institutes which incorporated drought and striga tolerances and then evaluate the status of Striga infestation and drought effect on farmers' field. Then sorghum genotypes which support significantly reduced Striga counts at moisture stress areas while producing reasonably high grain yield can hold promise for alleviating the problem. The result of this study indicated that considerable variability existed among the sorghum genotypes to Striga in terms of days to 75% maturity, plant height, striga count, thousands grains weight, grain and biomass yield. The major criteria used for selecting the genotypes that responded well to drought and striga stress condition were based on phenotypic data such as stay-green, maturity dates, and striga population and other major yield related traits. Taking into consideration of these criteria's in line with the combined analysis of variance, genotype 38, and 9 had promising result on grain yield respectively as compared the local(Dagnew landrace) and standard checks (Gobiye variety). Regarding striga tolerant/resistant trait, genotype 21 (9.5 striga population), genotype 22 (10.58) and Genotype 42 (10.83) showed less striga plant population per plot. Finally with considering the overall phenotypic performance (acceptability), stay greenness trait (1-5 scale), striga infestation (tolerant) and grain yield performance genotype 38 was selected. Hence, the best outstanding candidate was submitted as candidate genotypes for variety verification trial to be evaluated by variety verification committee and to be released for commercial production purpose in the 2019/20 cropping season.

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