Combining ability of maize (Zea mays L.) line for grain yield in Mali

ABSTRACT

Mali experiencesirregular and poor distribution of rainswhichlimitmaize production greatly. The studyobjective was to evaluatethe performance ofvariousmaizehybrids as well asdeterminegeneral and specificcombiningability of the linesunder water limited conditions. Twotrials wereconductedatSotuba and KasselainSouth-Western Mali with 23 genotypes in the first trial and 15 genotypes in the second trial. The experimental design wasacompletelyrandom Fisher block design. Morphological and agronomic traits wereevaluatedin a lines/testerscrossingschemewhere the testerswerefemales and the lineswereмales. Resultsshowedsignificantdifference (P< 0.05) for earheight, days to anthesis, days to silking, grain yield, leafwidth, plant aspect, and 1000 grain weight. In both sites,the generalcombiningabilitywassignificantlydifferent (P< 0.05) betweentesterswhereas the specificcombiningabilitydifferedsignificantly(P< 0.05) between thelines.The bestperforminghybridatSotubainterm of grainyieldwasobservedwithTZI1876/9071 (6,003kg/ha), and atKasselathe highestyieldingwasTZI1876/CML442 (6,320 kg/ha).

Keywords: Performance, hybrids,combiningability.

1. INTRODUCTION

The Savanaecology of sub-saharanAfrica has thepotentialto support expandedmaize production due to the ambientsolar, healthysoils, and availablemoisture[1]. As a result, maize has been adoptedextensively in the zone, replacing the traditionalcrops, sorghum [*Sorghumbicolor* (L.) Moench] and millet [*Pennisetumglaucum* (L.) R. Br.] [2].

In sub-SaharanAfrica, maize (*Zeamays* L.) is the most important cerealcropwhile the averageisstillverylow (1.3t/ha) compared to 8.6 t/ha obtained in developed countries [3]. In Mali, maizeis a staplefoodproviding carbohydrate, vitamin B, and minerals to an estimated 50% of the population.

Astudythatevaluated 200 maizeproducersreportedthathybridshad a positive impact on the to Maliansmallholderfarmers[4]A vastmajority of maizegrowersprefered the hybridsbecause of the good quality of the seed, the superior rates of germination, the size of grains, and productivity[4].However, farmerslack information on the recommended high yieldinghybridmaizelines to growdespite existence of many entries.

Based on geneticmakeup, hybrids of several types are possible in maize.Howeverthosederivedfrominbredlines are commonlyused for commercial production. The theory of specificcombiningability (SCA) and generalcombiningability (GCA) have been usedbroadly in breeding of severalcommercial cropspecies [5]. The generalcombiningabilitywasobserved to berelatively more important thanspecificcombiningabilityfor maizeyielddetermination of unselectedinbredlines, whilespecificcombiningabilitywas more important thangeneralcombiningability for previouslyselectedlines. Previousfindingsalso showthat the generalcombiningabilityislargely due to the additive effect of geneswhile in specificcombiningability dominance or epistaticeffects of genes are commonlyinvolved.[6]comparedestimates of the variances of generalcombiningability and specificcombiningability for yield and their interaction with locations and years. Theystressedthat the variance of specificcombiningabilityincludes not only the nonadditivedeviations due to dominance and epistasis but alsoaconsiderable portion of the genotype × environment interaction.

[7] recommendedtworeplications per location and three to five environments for evaluation of maize crosses, because the additive by environment interaction isusually a significant factor. Therefore, the objective of thisworkwastoevaluatethe performance of maize hybrids and determine the combiningability of maizelines.

3. MATERIAL AND METHODS

3.1 Experimental sites

The study was conductedin two sites, at the Sotubaagronomic research station (12 ^{o} 39'47" North, 7 ^{o} 55'02" West), soil is and inKassela village (12°35'42" N and7°39'58" W) soil is sandy-clayey. Sotuba agronomic research station has268 ha research land and is located on the left bank of the Niger River. The average annual rainfall in Sotubaranges between 1000 – 1200 mm.Kassela village is a part of Baguineda commune and receives annual rainfall ranging from 900 – 1 000 mm.The previous crop in both site was cowpea.

3.2. Plant material and experimental design

Two testers TZI1876 and V481-73 were usedin two different trials composed of.23 and 15 hybrids (Table1).The hybridswereobtainedfromSotuba station.

Table1. List ofmaize**hybridsfor two trialsper site**

Hybrids:23 entries trial		**Hybrids: 15entries trial**	
1-TZI1876/CML538	14-V481-73/CML502	1-TZI1876/CML53	14-TZI1876/S6 7-14
2-V481-73/CML538	15-TZI1876/S6 104-109	2-V481-73/CML538	15-V481-73/S6 7-14
3-TZI1876/CML505	16-V481-73/S6 104-109	3-TZI1876/CML505	
4-V481-73/CML505	17-TZI1876/J16-1	4-V481-73/CML505	
5-TZI1876/EXP 124-1	18-V481-73/J16-1	5-TZI1876/CML442	
6-V481-73/EXP 124-1	19-check	6-V481-73/CML442	
7-TZI1876/S6 1-6	20-TZI1876/9071	7-TZI1876/S6 1-6	
8-V481-73/S6 1-6	21-V481-73/9071	8-V481-73/S6 1-6	
9-TZI1876/CML 442	22-TZI1876/ 7-14	9-TZI11876/J16-1	
10-V481-73/CML 442	23-V481-73/ 7-14	10-V481-73/J16-1	
11-TZ1876/1368+PAC		11-TZI1876/9071	
12-V481-73/1368+PAC		12-V481-73/9071	
13-TZI1876/CML502		13-check	

Two trials composed of 23 and 15 hybrids were conducted in two sites todetermine maize line combining ability. The genotypesweredifferentfrom one trial to another and werecomposed of single hybridshavingtwotesters in common, namely TZI1876 and V481-73. The rowspacing was 0.75 m by 0.25 mwhile therow length was 5 m. The experimental design was randomized

complete block designwith three replications.Fertilizationwasperformedwithurea(150kg/ha) and NPK (100 kg/ha).

3.3. Measurements

The measurementsconductedincludedgrain yield, ear aspect, plant aspect, days to silking, days to anthesis, ear height, leaf width, plant height and thousand kernel weight.

Yield grain wasestimatedusing the followingformula:

Yield/ha = (X*FY*0.75*10000)/S

(100 – M) / (100 – 15) = X= grain yieldmoistureadjusted to 15%

Where M ismoisturerecordedduringharvest for each plot

Where FY isfieldyield and S plot areas.

15: Standard moisture content duringharvest

0.75 (75%) Shellingpercentage

100: Maximum of moisture.

10000: conversion of yield plot to hectare

Ear aspect rated on a scale of 1 to 5, where 1 = uniform well-filled ears and 5 = poorly filled ears with varying grain colours.

Plant aspect rated on a scale of 1 to 5, where 1 = good plant type with uniform ear placement and 5 = poor plant type with varying plant and ear heights.

Day to 50% silking: the number of days from emergence to when 50% of the plants in the plot produce silk.

Days to 50% anthesis: The number of days from emergence to when 50% of the plants started shedding pollen.

Plant height: Mean of three plants height randomly taken from each entry measured from ground to the base of tassel

Ear height:Mean of three ear height randomly taken from ground to the ear base

Leaf width: width ofleaf middle from three plants randomly taken

thousand kernel weight : Thousand kernels from each plot were counted by automatic seed conter and were weighted using balance

4. Data analysis

Software Gen Stat (12th Edition) was used for data analysis and software ''AGD-R'' for combining ability. The analysis of combining ability was based on the model described by [8] The GCA and SCA effects were examined for each environment.

The statistical model used for the combined analysis is as follows:

a. Model of combining ability for each environment

$Yijk = \mu + rk + fi + mj + (f \times m)ij + eijk$

Yijk: the observed measurement for the kth replication of the ixjth progeny

μ: experimental mean

fi: is the effect of the ith line (GCAlinei); I = 1, 2, 3….21

tj: is the effect of the jth tester (GCAtesterj); j = 1, 2, 3

(f x m) ij: is the interaction effect of the ith line with the jth male (SCAij)

rk: effect replication within environment; k = 1, 2

eijk: is the error effect associated with the ijkth observation

5- Results

5.1.1 Twenty-three(23) entries trialat Sotuba site

Table 2: Analysis of variance of observed traits

Source of variation	Df	Yield	Ear aspect	Plant aspect	Days to silking	Day to anthesis	Earheight	Leafwidth	Plant height	Thousandkernels weight
Replication	2	40519271	2.26	12.2754	12.9	27.2	0.125	4.35E-06	0.1159	1149
Hybrids	22	2548645	0.58	1.6311*	8.0	17.5	0.019	0.00008248*	0.0305	2757*
Residual	44	2664426	0.46	0.8208	5.4	18.9	0.015	0.0000392	0.0252	1567
Total	68									

There hybrids showedno yield differences (Table 2). However, the highest yield (6003kg/ha) was obtained withhybrid TZI1876/9071 (Table 3).

There was no difference among hybrids for ear aspectTable 2. However, the best ear aspect was observed with V481-73/CML538, TZI1876/S6 1-6 et TZI1876/CML442 (Table3).

There was significant difference among genotypes for plant aspect(Table 2). Hybrids TZI1876/CML442 et TZI1876/J16-1 had the best plant aspect (Table 3)

There was no difference among hybrids for day to 50%silkingTable 2. Day to 50 % silking is from 52 (TZI1876/S6 7-14) to 59 (TZI1876/CML502 et TZI1876/J16-1) (Table 3)

There was no difference among hybrids for day to 50% anthesisTable 2. Day to 50 % anthesiswas from 52 (TZI1876/S6 7-14) to 58 (TZI1876/J16-1 et TZI1876/1368+PAC) (Table 3)

There was no difference among hybrids for ear height (Table 2). The ear height was from 0.80 m (V481-73/1368+PAC) to 1.063 m (V481-73/S6 104-109) (Table 3)

There was significance difference among genotypes for leaf width (Table2).Leaf width was from 0.09 m to 0.113 m (Table3).

There was no difference among genotypes for plant height Table2. Plant height was from 1.85m to 2.217 m (Table3).

Significance difference was observed among hybridsTable2. Weight of thousandKernel was from 270g to 380 g for TZI1876/CML502 and V481-73/CML505 respectively. (Table3)

Table3. Mean of evaluated traits for Twenty-three (23)entriesatSotuba

Hybrids	Grain yield (kg/ha)	Plant aspect	Ear Aspect	50% day to silking	Day to 50% anthesis	Earheight (m)	Plant height (m)	leafwidth (cm)	1000 kernelsweight (g)
1TZI1876/CML538	3544	4	2.66	56	55	1.043	2.017	10	290
2-V481-73/CML538	3337	3.67	1.33	54	54	1.043	2.183	10	280
3-TZI1876/CML505	4812	2.33	1.66	55	55	0.957	1.983	10	296.7
4-V481-73/CML505	5767	2	2	54	54	0.823	1.867	9	383.3
5-TZI1876/EXP 124-1	3541	2.33	1.66	57	56	0.887	2.017	10	323.3
6-V481-73/EXP 124-1	3588	1.67	3	57	57	0.93	2.1	10.333	323.3
7-TZI1876/S6 1-6	4582	2	1.33	56	56	0.83	2.017	9.667	303.3
8-V481-73/S6 1-6	4351	2.33	2.33	54	48	0.9	2.05	10.667	290
09-TZI1876/CML 442	5564	1	1.33	56	56	0.99	2.117	9.667	326.7
10-V481-73/CML 442	4422	2.33	2	58	57	0.947	2.017	10.333	263.3
11-TZI1876/1368+PAC	4371	2.33	2	58	58	0.877	2.083	10	323.3
12-V481-73/1368+PAC	3628	2	2.66	57	56	0.8	1.867	9.333	286.7
13-TZI1876/CML502	4443	1.33	1.66	59	50	1.017	2.1	10	270
14-V481-73/CML502	5461	3	1.66	56	55	0.933	2.117	10.333	310
15-TZI1876/S6104-109	2693	2.33	2	54	54	0.91	2.217	9.667	380
16-V481-73/S6104-109	5002	3	2	54	54	1.063	2.05	10	326.7
17-TZI1876/J16-1	5711	1	1.66	59	58	1.053	2.217	9.667	336.7
18-V481-73/J16-1	4911	1.67	1.66	56	55	0.967	2.067	11.333	310
19-check	5329	1.67	1.66	57	57	0.94	1.85	11.333	273.3
20-TZI1876/9071	6003		1.66	56	56	1.033	2.15	9.667	300
21-V481-73/9071	5323	2.67	2	56	55	0.963	2.15	9	290
22-TZI1876/S6 7-14	4244	2	1.66	52	52	0.833	2.033	10	306.7
23-V481-73/ 7-14	3374	2	2.33	55	54	0.863	2.05	9.667	300
Mean	4522	2.19	1.91	56	55	0.939	2.057	9.913	308.4
Significance	-	*	-	-	-	-	-	*	*
LSD	2686	1.491	1.203	3.8	7.2	0.2022	0.2611	0.010302	65.15
CV%	36.1	41.4	38.3	4.2	7.9	13.1	7.7	6.3	12.8

5.1.2.Fifteen (15) entriestrial

Table 4: Mean square from analysis of variance for evaluated traits

Source of variation	Df	Grain yield	Ear aspect	Plant aspect	Day to 50% silking	Day to 50% anthesis	Earheight	Leafwidth	Plant height	ThousandKernelweight
Repetition	2	40003486	0.9556	0.5556	40.56	46.82	0.09891	0.9556	0.1623	4442
Entries	14	1854286	0.3746	1.1746*	18.78	21.99*	0.02211	0.6889	0.01605	1499
Residual	28	2436330	0.5508	0.627	15.1	10.13	0.01404	0.5032	0.01843	2021
Total	44									

The ANOVA showed no difference among the genotypes with regards to grain yield, ear aspect, plant aspect, day to 50% silkingear height, leaves width, plant height, and thousand kernels weight (Table 4). However, there was variations among the hybrids (Table 5).Thehighest grain yield (5281 kg/ha) was observed with hybrid V481-73/S6 7-14, whereas hybrids TZI1876/CML505, TZI1876/J16-1 and V481-73/J16-1 had the best ear aspect. Hybrids TZI1876/CML505, TZI1876/CML442, V481-73/CML442, TZI1876/J16-1 and V481-73/J16-1 had the best plant aspect (Table 5).

Days to 50% silkingrangedfrom 52 to 59 for V481-73/S6 7-14 and TZI1876/CML442 respectively (Table5). Ear height was from 0.86 cm to 1.09 cm for V481-73/S6 1-6 and TZI1876/CML442 respectively. Leaf width was from 9 cm to 10.6 cm for V481-73/S6 7-14, V481-73/J16-1, and TZI1876/9071 respectively. Plant height was from 1.95 m to 2.217 m for V481-73/S6 1-6 and TZI1876/CML442 respectively. Thousand kernels weight was from 263.3 g to 340 g forTZI1876/J16-1 and V481-73/S6 1-6 respectively (Table 5).

In converse, there was significant difference ($P< 0.05$) among hybrids for days to 50% anthesis (Table 4). Days to 50% anthesis ranged from 52 to 59 for V481-73/S6 7-14 and TZI1876/CML442 respectively (Table 5).

Table5: Mean of evaluated traits for Fifteen 15 entriesTrial at Sotuba

Hybrids	Grain yield (kg/ha)	Ear aspect	Plant aspect	Days to 50% silking	Days to 50% anthesis	Earheigh (m)	Plant height (m)	Leafwidth (cm)	Thousandkernelsweight (g)
1-TZI1876/CML538	4907	2	2.33	57	57	1	2.017	10.3	283.3
2-V481-73/CML538	3178	2.33	1.33	55	55	0.87	1.967	10	303.3
3-TZI1876/CML505	5401	1	1.33	54	53	0.96	1.967	10	320
4-V481-73/CML505	4442	1.67	1	48	53	0.99	2.067	9.33	263.3
5-TZI1876/CML442	3292	1.67	1	59	58	1.14	2.217	10	280
6-V481-73/CML442	4144	1.67	1	57	57	1.09	2	9.67	320
7-TZI1876/S6 1-6	5111	1.33	1.33	55	46	0.88	2.1	10	303.3
8-V481-73/S6 1-6	4056	1.67	1.33	54	54	0.86	1.95	9.33	340
9-TZI11876/J16-1	5068	1	1	54	54	1.07	1.967	10.3	263.3
10-V481-73/J16-1	4413	2	1	57	56	0.88	2.033	10.6	300
11-TZI1876/9071	3835	1.67	1.33	56	56	1.02	2.017	10.6	293.3
12-V481-73/9071	4671	1.33	1.67	55	56	1.06	2	9.67	273.3
13-check	3119	1.67	2.33	56	55	1.01	2.087	10	310
14-TZI1876/S6 7-14	5253	1.67	2.67	55	54	0.95	2.133	9.67	320
15-V481-73/S6 7-14	5281	1.67	2.67	52	52	0.96	2.033	9	300
Mean	4411	1.62	1.56	55	54	0.98	2.037	9.91	298.2
Significance	-	-	*	-	*	-	-	-	-
LSD	2610.6	1.241	1.324	6.5	5.3	0.1981	0.2271	1.186	75.19
CV%	35.4	45.7	50.9	7.1	5.8	12	6.7	7.2	15.1

5.2 Kassela Site

5.2.1ResultsTwentythree(23) entries trial

Table6: Mean squares from analysis of variance of evaluated traits

Source of variation	Df	Grain yield	Ear aspect	Plant aspect	Day to 50% silking	Day to 50% anthesis	Earheight	Leafwidth	Plant height	ThousandKernelweight
Repetition	2	4825799	2.1449	9.841	2.797	8.014	37.34	0.0002261	0.01668	1149
Entries	22	3210561*	0.9829*	3.863	14.989**	15.827**	37.46	0.0001424	0.07729	2757*
Residual	44	1478739	0.4631	3.280	6.055	6.181	38.14	0.0002094	0.05436	1567
Total	68									

Significance difference was observed among hybrids for grain yield (Table6). The best grain yield was 6320 kg/ha for TZI1876/CML442 (Table 7)

There was not difference among hybrids for plant aspect(Table6). Plant aspect was from 1.33 to 6.33 (Table7)

Significance difference was observed among hybrids for ear aspect(Table6). Ear aspect was from 1 to 2.66(Table7)

Significance difference was observed among hybrids for day to 50% silking(Table6). Day to 50% silking was from 53 to 63 with V481-73/S6 1-6 and TZI1876/J16-1 respectively (Table7)

There was significance difference among hybrids for day to 50% anthesis(Table6). Day to 50% anthesis was from 53 (V481-73/CML505 and V481-73/S6 1-6) to 62 (TZI1876/J16-1) (Table7)

There was no difference among hybrids Table for ear height6. Ear height was from 0.74 m to 1.78m for TZI1876/S6 7-14 and TZI1876/CML442 respectively(Table 7)

There was no difference among hybrids for leaf width(Table6). Leaves width was from 0.1 to 0.7 cm (Table7)

There was no difference among hybrids for plant height. (Table6). Plant height was from 0.70m to 2.40 m for TZI1876/S6 7-14 and TZI1876/1368+PAC respectively (Table7)

There was no difference among hybrids for thousand kernels(Table6). Weight was from 240 to 350g with check and TZI1876/CML505 respectively (Table7)

Table7: Mean of evaluated traits at Kassela trial 23 entries

Hybrids	Grain yield (kg/ha)	Plant aspect	Ear aspect	Days to 50% silking	Days to 50% anthesis	Earheigh t	Leafwidth (cm)	Plant height (cm)	Thousandkernels weight (g)
1- TZI1876/CML538	3255	2.33	1.00	57	57	1	9	2.2	286.7
2- V48173/CML538	2833	2.33	1.67	58	57	0.77	8.67	1.9	243.3
3- TZI1876/CML505	4561	1.67	1.00	56	55	1.08	9.67	2.27	350
4- V48173/CML505	3623	6.33	1.33	55	53	1.08	8.67	1.97	320
5- TZI1876/EXP124-1	4889	1.33	1.33	55	55	1.02	9.67	2.37	313.3
6.V481-73/EXP124-1	3526	2.67	2.00	60	59	0.77	9	2.18	293.3
7- TZI1876/S6 1-6	3886	2	1.00	55	55	0.77	8.67	2.2	316.7
8-V481-73/S6 1-6	4657	1.33	1.67	53	53	0.95	8	2.25	293.3
9- TZI1876/CML442	6320	2.33	1.33	59	59	17.82	9.67	2.18	330
10- V48173/CML442	4145	2.67	2.00	57	57	0.89	9.67	2.23	290
11- TZI1876/1368+PAC	3799	1.67	1.33	57	57	0.88	7.33	2.4	320
12- V48173/1368+PAC	4007	1.67	2.00	57	56	0.97	10	2.12	310
13-TZI1876/CML502	2017	2.33	2.33	59	59	0.85	9	2	270
14-V481-73/CML502	3721	2.67	2.33	55	54	0.94	9.33	2.27	253.3
15- TZI1876/S6 104-109	2016	3.33	2.67	59	59	0.78	8.67	2.02	256.7
16-V48173/S6104-109	3184	2.67	2.33	57	56	0.9	8.67	1.98	263.3
17-TZI1876/J16-1	3209	2.33	2.67	63	62	0.86	10	2.12	296.7
18-V481-73/J16-1	3321	2.67	2.00	55	55	0.9	9	2.23	286.7
19-check	2543	2.67	2.67	60	59	0.76	10	2.1	240
20-TZI1876/9071	3291	2.67	1.67	58	58	0.92	8.67	2.2	306.7
21-V481-73/9071	2609	3.33	2.33	58	57	0.82	8.67	1.97	250
22-TZI1876/ 7-14	2065	5	2.67	57	57	0.74	8	1.7	256.7
23-V481-73/ 7-14	2360	3.67	2.33	55	55	0.92	9	2.13	283.3
Mean	3471	2.68	1.90	57	57	1.62	9	2.13	288.3
Significance	*	-	*	**	**	-	-	-	-
LSD	2094.6	-	1.20	4	4.1	-	-	-	-
CV%	36.7	70.4	38.60	4.3	4.4	381.1	16.1	10.8	16.8

5.2. 2Fifteen (15) entries Trial

Table8: Mean square from anlysis of variance for evaluated traits atKassela

Source of variation	df	grain yield	Ear aspect	Plant aspect	Days to 50% silking	Days to 50% anthesis	Earheight	Leafwidth	Plant height	Thousandkernelsweight
Replication	2	9850869	4.4222	9.8000	16.956	15.622	0.21215	0.0001489	0.24156	4776
Entries	14	1054287.*	0.2603	0.3714	11.803*	12.232	0.02224	0.0002546	0.03232	546
Résidual	28	514668	0.2317	0.5143	5.741	6.717	0.03905	0.0002227	0.02019	1937
Total	44									

There was significant difference among hybrids for grain wield. (Table8). The best grain yield was 4964 kg/ha with V481-73/S6 7-14(Table9)

There was not significant difference among hybrids for ear aspect(Table8). Ear aspect was from 2.33 to 1.33 (Table9)

There was not significant difference among hybrids for plant aspect (Table8). Plant aspect was from2.33 to 3.33 (Table9)

Significant difference was observed among hybrids for day to 50% silking(Table8). Day to 50% silking was from 51 to 57 with V481-73/CML505 and TZI1876/CML538 respectively(Table9)

There was not significant difference among hybrids for day to 50% anthesis(Table8). Day to 50% anthesis was from 51 to 57 with TZI1876/S6 7-14 and TZI1876/CML538 respectively (Table9)

There was not significant difference among hybrids for ear height (Table8). Ear height was from 0.670 m to 0.960 m with V481-73/S6 7-14 and TZI1876/CML538 respectively(Table9)

There was not significant difference among hybrids for leaves width(Table8). Leaves width was from 0.06 to 0.09 m.(Table9)

There was not significant difference among hybrids plant height (Table8). Plant height was from 1.88m to 2.21 m with TZI1876/CML538 and V481-73/J16-1 respectively(Table9)

There was not significant difference among hybrids for thousand kernels weight(Table8). Grain weight was from 276.7g to 326.7g with TZI1876/CML442 andTZI1876/S6 7-14 respectively(Table9)

Table9: Mean of evaluated traits for Fifteen (15) entries at Kassela

Hybrids	Grain yield (kg/ha)	Ear aspect	Plant aspect	Days to 50% silking	Day to 50% anthesis	Earheight (m)	Plant height (m)	Leaveswidth	Thousandkernelsweight (g)
1-TZI1876/CML538	2905	1.333	2.67	57	57	0.57	2.017	15	303.3
2-V481-73/CML538	2939	2	3	55	55	0.96	2.15	8.67	303.3
3-TZI1876/CML505	4094	2.333	3.33	54	53	0.83	2	6	293.3
4-V481-73/CML505	3263	1.667	3.33	51	52	0.787	2.2	9.33	316.7
5-TZI1876/CML442	2989	1.333	2.67	56	56	0.943	2.25	9.33	276.7
6-V481-73/CML442	3647	1.667	2.67	56	56	0.67	2.133	9.33	290
7-TZI1876/S6 1-6	3393	1.667	2.33	54	52	0.82	2.25	9.33	303.3
8-V481-73/S6 1-6	3331	1.667	3	50	50	0.833	2.167	9.33	310
9-TZI11876/J16-1	3074	1.333	3.33	54	54	0.857	2.083	9.33	293.3
10-V481-73/J16-1	3954	1.667	3	52	52	0.87	2.217	9.33	296.7
11-TZI1876/9071	3823	1.333	2.67	54	54	0.867	2	8.33	316.7
12-V481-73/9071	2725	1.667	2.67	54	54	0.917	2.05	8.67	283.3
13-check	3237	1.333	2.33	56	56	0.963	2.133	9.33	310
14-TZI1876/S6 7-14	2925	1.333	2.67	52	51	0.793	2.183	9.67	326.7
15-V481-73/S6 7-14	4960	1.333	2.33	55	55	0.983	2.067	9.67	293.3
Mean	3417	1.578	2.8	54	54	0.87	2.118	9.02	301.1
Significance	*	-	-	*	*	-	-	-	-
LSD	1199.9	-	-	4	4.3	-	-	-	-
CV%	21	30.5	25.6	4.4	4.8	22.7	6.7	16.5	14.6

5.3. Grain yield for Twenty three(23) entries trial at Sotuba and Kassela

There was no difference among genotypes for grain yield at Sotuba and Kassela(Table10)

Table10: Analysis of variance for grain yieldfor Twenty three (23) entries trial at Sotuba and Kassela

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr
Site	1	12691353.	12691353.	16.99	
Entries	22	25810458.	1173203.	1.57	0.148
Résidual	22	16429546.	746798		
Total	45	54931357			

The best hybrid in term of grain yield was 5.943 t/ha with TZI1876/CML442 (Table11)

Table11: Mean of grain yield Twenty three (23) entries trial at Sotuba and Kassela

Hybrids	Grain yield (kg/ha)
1-TZI1876/CML538	3400
2-V48173/CML538	3085
3TZI1876/CML505	4686
4-V48173/CML505	4695
5-TZI1876/EXP124-1	4215
6-V481-73/EXP124-1	3557
7-TZI1876/S6 1-6	4234
8-V481-73/S6 1-6	4504
9-TZI1876/CML442	5943
10V48173/CML442	4284
11TZ1876/1368+PAC	4085
12V48173/1368+PAC	3818
13-TZI1876/CML502	3230
14-V481-73/CML502	4591
15TZI1876/S6 104-109	2355
16-V48173/S6104-109	4093
17-TZI1876/J16-1	4460
18-V481-73/J16-1	4116
19-check	3936
20-TZI1876/9071	4647
21-V481-73/9071	3966
22-TZI1876/S6 7-14	3155
23-V481-73/S6 7-14	2867
Mean	3997
Significance	-
LSD	1.792.2
CV%	2..1.6

5.4. Grain yield for Fifteen (15 entries) Trialat Sotuba and Kassela

There was not difference among hybrids for trial15 entries at Sotuba and Kassela(Table12)

Table12:Analysis of variance for grain yield Fifteen (15) entriestrial at Sotuba and Kassela

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr
Sites	1	7415241.	7415241.	21.49	
Entries	14	8746806.	624772.	1.81	0.139
Residual	14	4830527.	345038		
Total	29	20992573.			

The best grain yield was 5.120 t/ha with V481-73/S6 7-14(Table13)

Table13Mean of grain yield Fifteen (15) entries trial (SotubaandKassela)

Hybrids	Grain (kg/ha)
1-TZI1876/CML538	3906
2-V481-73/CML538	3058
3-TZI1876/CML505	4748
4-V481-73/CML505	3852
5-TZI1876/CML442	3139
6-V481-73/CML442	3896
7-TZI1876/S6 1-6	4252
8-V481-73/S6 1-6	3694
9-TZI11876/J16-1	4071
10-V481-73/J16-1	4184
11-TZI1876/9071	3829
12-V481-73/9071	3698
13-check	3178.
14-TZI1876/S6 7-14	4089.
15-V481-73/S6 7-14	**5120.**

Mean	3.914.
Significance	-
LSD	1.259.8
CV%	1.5.0

5.5 Combiningabilityatdifferents sites

- **Sotuba siteTwentythree(23) entries trial**

There was significant difference among testers(Table 14). Tester 2 V481-73 had best General combining ability figure 1A.Line CML442 had the best general Combining Ability for both TZI1876 and V481-73 figure1B. Hybrid V481-73/S6 1-6 had the best Specific Combining Ability figure 1C

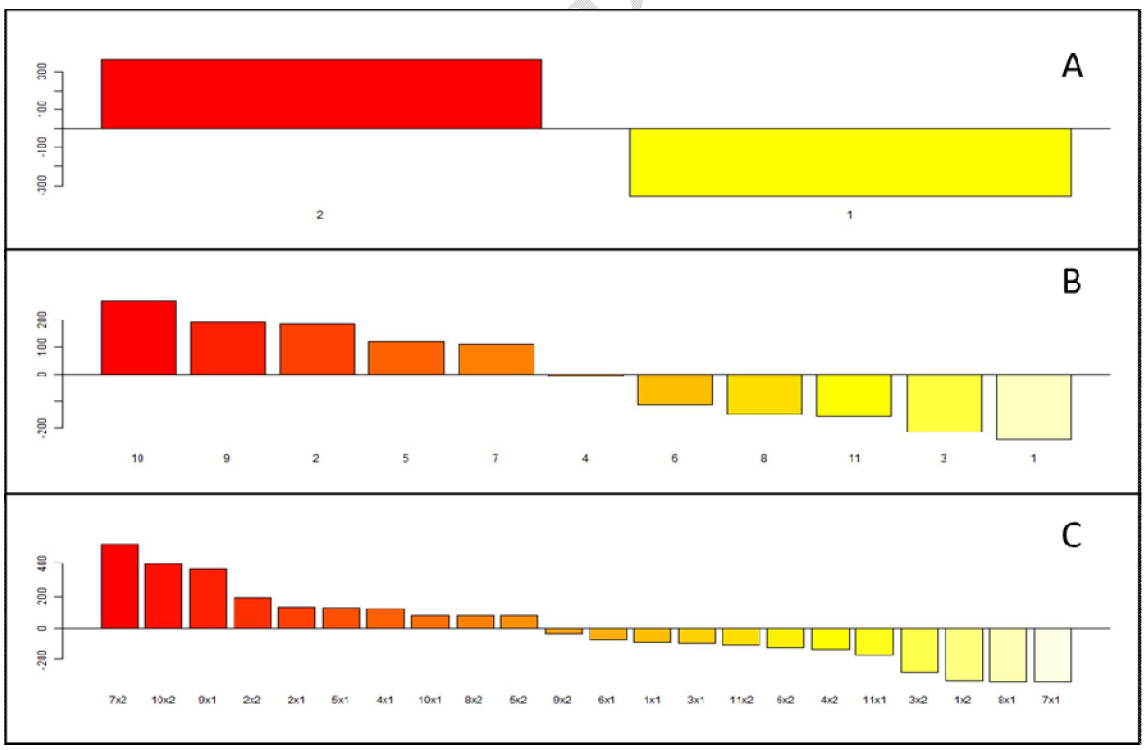


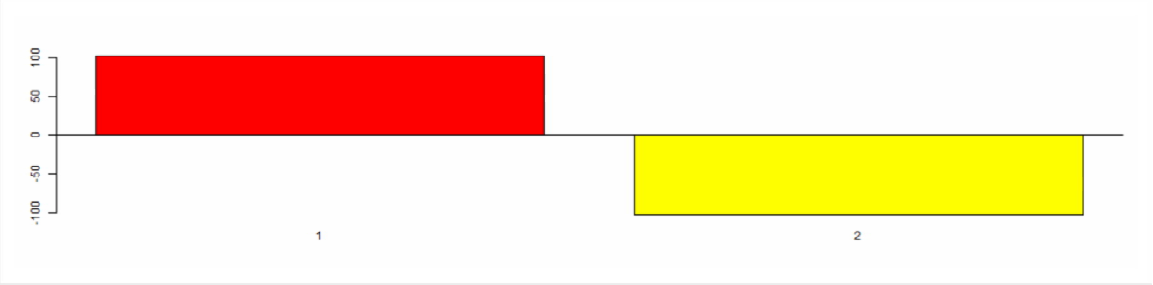
Figure 1: General Combining Ability for the best tester (V481-73) (A), best lines (CML442) (B) and specific combining Ability for the best Line/tester (V481-73/S6 1-6) (C)

Tablea14 :Testers General combining Ability trial 23 entries (Sotuba)

Testers	Mean	GCA	Standard_Error	T_Value	Prob_T	Rank
1. TZI1876	4485,084	-362,957	276,96	-1,3105	0,414955	2
2. V481-73	4485,084	362,9572	276,96	1,310504	0,414955	1

T Value=Test Value ; Pro T=Probability Test

- Sotuba site Fifteen (15 entries) Trial



There was significant difference among testers for General Combining AbilityTable 15. Tester 1 TZ1876 had the best General Combining Ability figure 2. Hybrid V481-73/CML442 had the best Specific Combining Ability figure 3

Figure 2: General combining Ability for the best tester(TZI1876)

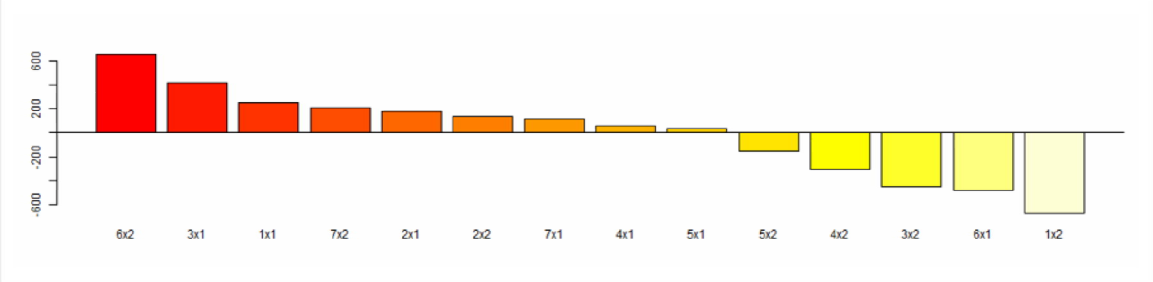


Figure 3-: Specific combining Ability for the best hybrid (V481-73/CML442)

Table 15: Testers General combining Ability trial 15 entries (Sotuba)

TESTER	GRAN_MEAN	GCA	Standard_Error	T_Value	Prob_T	GCA_RANK
1	4876,509	102,6885	198,6893	0,51683	0,696319	1
2	4876,509	-102,688	198,6893	-0,51683	0,696319	2

- **Kassela siteTwentythree(23) entries trial**

  There was significant differance among testersTable 16. Tester TZI 1876 had the best General Combining Ability figure 4A. Line EXP 124-1 had the best General Combining Ability for both tester figure 4B.

There was no difference among lines for Specific combining Ability Table 17

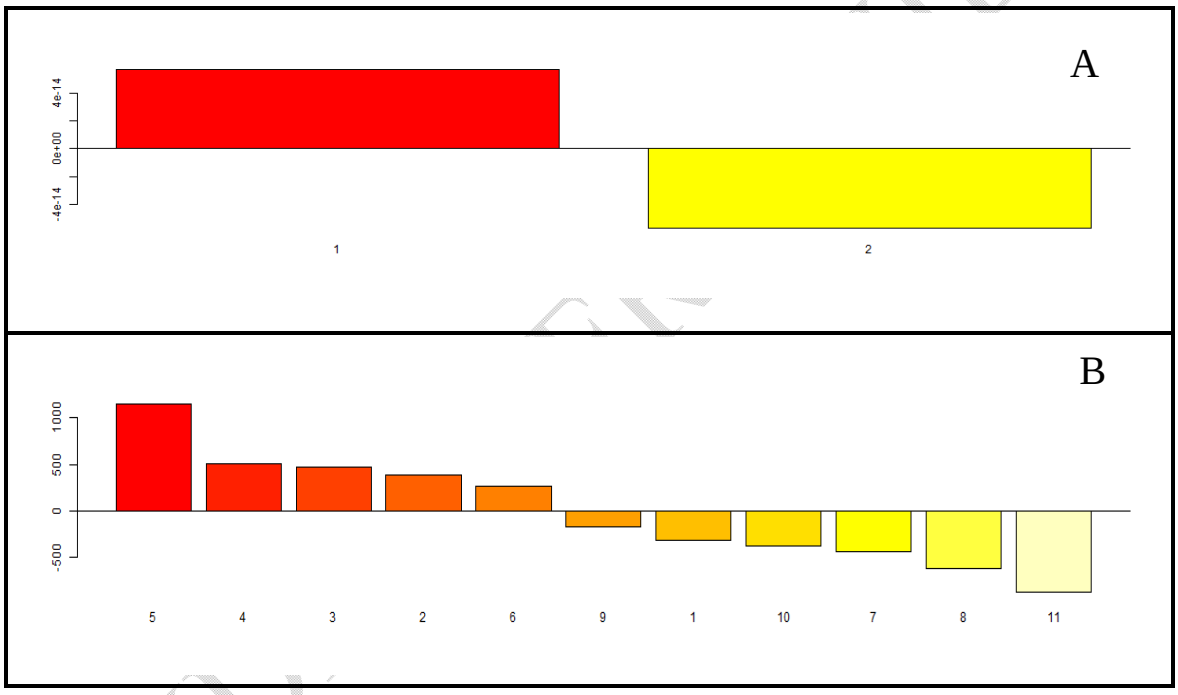


Figure 4 : General Combining Ability for the best tester TZI1876 23 entries A General Combining Ability for the best lines 23 entries. B

Table16 : Testers General combining Ability trial 23 entries (Kassela)

TESTER	GRAN_MEAN	GCA	Standard_Error	T_Value	Prob_T	GCA_RANK
1	3513,41	5,7E-14	1,38E-05	4,13E-09	1	1
2	3513,41	-5,7E-14	1,38E-05	-4,1E-09	1	2

Table17: Specific Combinig Ability 23 entries(Kassela)

Lines	Testers	Mean	SCA	Standard_Error	Rank
1. TZI1876/CML538	1. TZI1876	3513,41	0	0	11,5
1. TZI18976/CML538	2. V481-73	3513,41	0	0	11,5
10. V481-73/CML442	1. TZI1876	3513,41	0	0	11,5
10. V481-73/CML442	2. V481-73	3513,41	0	0	11,5
11. TZI1876/1368+PAC	1. TZI1876	3513,41	0	0	11,5
11. TZI1876/1368+PAC	2. V481-73	3513,41	0	0	11,5
2V481-73/CML538	1. TZI1876	3513,41	0	0	11,5
2. V481-73/538	2. V481-73	3513,41	0	0	11,5
3. TZI1876/CML505	1. TZI1876	3513,41	0	0	11,5
3TZI1876/CML505	2. V481-73	3513,41	0	0	11,5
4. V481-73/CML505	1. TZI1876	3513,41	0	0	11,5
4V481-73/CML505	2. V481-73	3513,41	0	0	11,5
5. TZI1876/EXP124-1	1TZI1876	3513,41	0	0	11,5
5. TZI1876/EXP124-1	2V481-73	3513,41	0	0	11,5
6. V481-73/EXP124-1	1. TZI1876	3513,41	0	0	11,5
6. V481-73/EXP124-1	2. V481-73	3513,41	0	0	11,5
7. TZI1876/S6 1-6	1. TZI1876	3513,41	0	0	11,5
7TZI1876/S6 1-6	2. V481-73	3513,41	0	0	11,5
8. V481-73/S6 1-6	1. TZI1876	3513,41	0	0	11,5
8. V481-73/S6 1-6	2. V481-73	3513,41	0	0	11,5
9. TZI1876/CML442	1. TZI1876	3513,41	0	0	11,5
9. TZI1876/CML442	2. V481-73	3513,41	0	0	11,5

T Value=Test Value ; Pro T=Probability Test ; N/A=Non Applicable

- **Kassela Site Fifteen (15) entries trial**

There was not difference among testers for General Combining AbilityTable18. Line S6 1-6 **had the best General combining Ability** figure 5A. It had the best Specific Combining Ability with V481-73 figure 5B

Table**N°**18gives cross rankper crosses and the best hybrid was (TZI1876/S6 1-6)

Table 18: General Combining Ability for testers 15 entries (Kassela)

Testers	Mean	GCA	Standard_Error	Rank
1. TZI1876	3429,989	0	0	1,5
2. V481-73	3429,989	0	0	1,5

T Value=Test Value ; Pro T=Probability Test ;N/A=Non Applicable

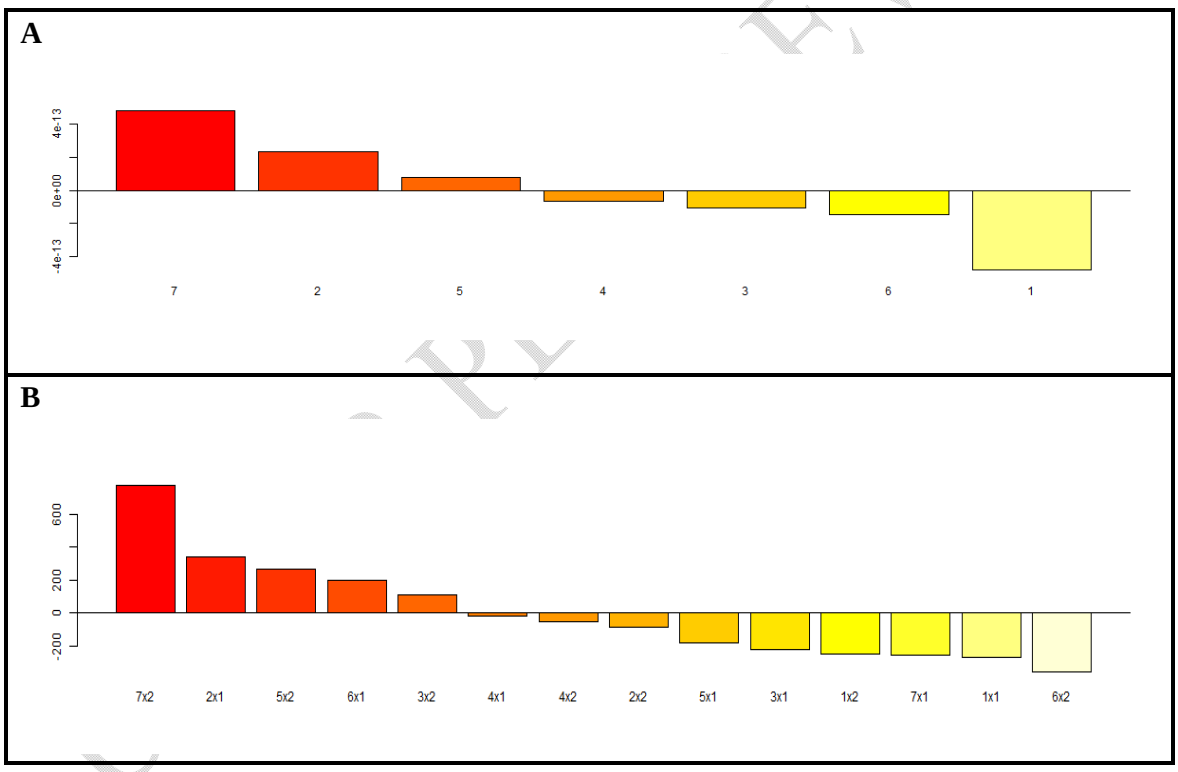


Figure 5 : General combining Ability for the best lines 15 entries A

Specific Combining Ability for the best hybrid 15 entries. B

6. DISCUSSION

In the currentstudy, Tester V481-73 showed agood general combining ability at Sotuba. The same result has been found by[9]. The best grain yield was 6320 kg/ha with TZI1876/CML442. This yield was better than the one found by [9] using the same tester TZI1876 (4840kg/ha).

The Specific combining ability has been foundwith hybrid TZI1876/9071 (6003 kg/ha) Trial 2. The one found with [9] was hybrid TZI1876/87036 with 4640 kg/ha in term of grain yield. For trial 3 General Combining Ability was obtenained with TZI1876. Specific Combining Ability was obtenained with V481-73/CML 442. Trial 1. General and Specific Combining Ability was obtenained with S6 1-6 for trial 1 at Kassela. However, for trial 2 General Combinig Ability and Specific Combining Ability were obtenained with TZI1876 and V481-73/ S6 1-6 respectively. Testers react to lines differently. In term of Grain yield mean from both sites namely Sotuba and Kassela the best hybrid for trial 1 was TZI1876/CML442 with 5943kg/ha. For trial two the best grain yield was 5120 /kg/ha with V481-73/S6 7-14. The two testers reacted differently according to sites and lines.

Grain yield found in both sites sotuba and kassela was low compared to the potential of hybrids 4370 kg/ha-8073 kg/ha [10]. Thousand kernels weight was from 263.3 grams to 380 grams at Sotuba and from 240to 276.7g at Kassela. These weights were low compared to those found by [11] where the best weight was 511.25 grams. Kernel weight could influence grain yield. From two trials at Sotuba and Kassela mean of day to 50% anthesis and day to 50 % silking were 56 and 55 respectively for 23 entries trial. At Kassela, mean of day to 50% anthesis and days to 50 % silking were 57 for both traits for 23 entries trial and 54 for both traits for 15 entries trial. 55 and 54 for 15 entries trial. Plant aspect mean was better at Sotuba 2.19 and 1.56 for 23 and 15 entriestrials respectivelythan Kassela trials. This difference is due to soil nature. However mean of ear aspect was better at kassela 1.8 and 1.5 for 23 and 15 entries trials respectively against 1.9 and 1.6 at Sotuba. This good ear aspect at kassela revealed good grain yield. The best grain yield was found at Kassela 6320 kg/ha with TZI1876/CML442. After investigation we realized that farmer used poultry organic manure. A part of ear height at kassela site where there was 1.62 m and 0.870 m for 23 entries trial and 15 entries trial, respectively plant height, ear height and leave width were almost the same in term of mean.

7. CONCLUSION

This work was to evaluate hybrids performance and combining ability of maize lines in Mali two sites. Two trials were conducted. The first was composed of 23 hybrids and the second was composed of 15 hybrids. All these hybrids had in common two testers.

At Sotuba with 23 hybridsTester 2 V481-73 had best General combining ability

Line CML442 had the best general Combining Ability for both TZI1876 and V481-73

Hybrid V481-73/S6 1-6 had the best Specific Combining Ability. However, with 15 hybrids Tester 1 TZ1876 had the best General Combining Ability. Hybrid V481-73/CML442 had the best Specific Combining Ability.

At kassela with 23 hybrids Tester TZI 1876 had the best General Combining Ability. Line EXP 124-1 had the best General Combining Ability for both testers.However, there was not difference among testers for General Combining Ability. Line S6 1-6 had the best General combining Ability. It had the best Specific Combining Ability with V481-73. This line in six generation selfing will be include in our breeding programm.

Testers reacted to lines differently according to sites.

8. PERSPECTIVES

This work must be done second time to confirm results at the same time increase sites number. The best hybrid was 6320 kg/ha with TZI1876/CML442. This hybrid will be tested at on farm trial for farmers appreciation. This hybrid will be tested at area where rainfall is above 600 mm.

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