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Developing Silage Maize Hybrids with the Cooperation Among Public Agricultural Research Institutes of Turkey

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Abstract

Due to the need for silage maize in livestock sector, its production in Turkey is increasing. Approximately 32% of the total maize plantings area of Turkey is being used to produce silage maize. Although, both public and private sector organizations released new high yielding and quality hybrids, there is still a gap for different hybrids that have high yield potential and good enough for different environments. To meet the mentioned gap, collaboration between national agricultural research institutes which have been working on maize was initiated. Silage maize inbred lines that developed by different institutes were used in hybridization. During hybridization studies, genetic background of the inbred lines and their yield and quality potential was considered. Experimental hybrids and commercial checks were tested in different locations of Turkey. Every year at least 15 experimental hybrids were evaluated in at least four locations of Turkey. Promising hybrids were determined and used for further investigations by the breeders. The first mutual silage maize hybrid, SAMADA-07 released in 2009. This hybrid's male and female parents belong to two institutions. Another mutual silage maize hybrid AGA is now available for farmers. SASA-5 hybrid also will be released in a near future.
In this study, past and present collaborative efforts on silage maize hybrid development by national agricultural research centers of Turkey were presented and experiment results from different sites were discussed.

Keywords: Maize breeding, animal feed, variety development, yield, quality

INTRODUCTION

Maize silage is an important quality forage source for dairy and cattle fattening in Turkey. Due to high energy potential, high dry matter yield and high silage performance, farmers of Turkey prefer maize silage when compared other feed sources. Maize silage is in the first rank in cattle feeding in Turkey (Sahin and Zaman, 2010). On the other hand, almost all geographic regions of Turkey are suitable for a profitable cultivation of silage maize. Modern technologies such as packing silage in the harvest and using it when need gives small scale farmers many advantageous. Silage aimed maize production in Turkey is increasing (TUIK, 2016).

According to the statistics, currently Turkey is producing 20 million ton silage maize annually (Table 1). Silage yield and quality is also increasing due to modern cultivation technologies (Erdal et al. 2016) and high yielding varieties. In order to improve yield and quality potential, maize breeding takes an important place. Public maize breeding studies related to silage maize in Turkey is still going on (Erdal et al. 2009; Erdal and Pamukcu 2011; Cengiz, 2016).

Table 1. Turkey silage maize planting area (da), production and yield data

Years	Planting area (da)	Production (ton)	Yield (kg/da)
2004	1. 550.000	6.200.000	4.000
2005	2. 000. 000	7.600.000	3.800
2006	2. 598. 913	10.069 968	3.875
2007	2. 690 132	10.259 595	3.814
2008	2. 888.829	11.183.290	3.871
2009	2.740. 031	11. 099. 653	4.051
2010	2. 937. 336	12. 446. 450	4.237
2011	3. 127. 946	13. 294. 380	4.250
2012	3. 540 .882	14. 956 .457	4.224
2013	4 .027 .160	17. 835. 115	4.429
2014	4. 149. 529	18. 563. 390	4.474
2015	4. 231. 233	19. 684. 599	4.652
2016	4. 257. 753	20. 139 .033	4.730

Silage maize breeding studies are being carried out by Bati Akdeniz Agricultural Research Institute (BATEM), Maize Research Institute (MAIM) and Black Sea Agricultural Research Institute (KATAE) national public institutes. Maize inbred lines developed by the institutes used to improve maize varieties separately by each institute. Although there was strong relationship among the institutes related to silage maize breeding, a concept was developed to foster breeding studies. According to this strategy, developed maize inbred lines by each institute were crossed to each other to develop high quality and yielding silage hybrids. Joint hybrids were made with some of the developed lines owned by the Institutes. These hybrids were tested in multiple locations and very promising results were obtained. The first mutual silage maize hybrid, SAMADA-07 released in 2009. This hybrid's male and female parents belong to two institutions. Another mutual silage maize hybrid AGA is now available for farmers. SASA-5 hybrid also is expected to be released in a near future.

In this study, past and present collaborative efforts on silage maize hybrid development by national agricultural research centers of Turkey were presented and experiment results from different sites were discussed.

MATERIALS and METHODS

Silage maize inbred lines that developed by different institutes were used to generate experimental hybrids. The hybrids were coded as SASA during studies. All hybridization studies were done in MAIM institute in Sakarya-Turkey. BURAK, P.31Y43, SAMADA-07 and KILOWATT commercial checks were used in the experiments. Experiments were carried out according to randomized complete block design with three replications. Antalya (Mediterranean region), Sakarya (Marmara region), Samsun (north region of Turkey), İzmir (Aegean region) and Maras and S.Urfa (South east Turkey) locations were used as test sites. Yield trials which were carried out in 2014 year in different sites of Turkey discussed in this study.During studies, traits were determined according to the Technical Instructions for Agricultural Trials in Maize (TTSM, 2015). Content analysis of dry matter (DM, %) and crude fiber (CF, %) was performed according to the Weende analysis method (AOAC, 1984). Neutral detergent fiber (NDF, %), acid detergent fiber (ADF, %) and acid detergent lignin (ADL, %) were determined (Van Soest et al. 1991).

RESULTS and DISCUSSION

Traits of the released mutual silage maize hybrids were presented in Table 2. SAMADA-07 silage maize hybrid was developed by crossing KATAE and MAIM silage maize inbred lines. This variety is a relatively late (FAO-750) hybrid. It has a high yield and quality potential and this variety is suggested for many regions of Turkey. AGA is another mutual silage maize hybrid that developed by cooperation among MAIM and BATEM research centers. This variety was released in 2015 and suggested for Mediterranean, Marmara, Black Sea and Eagan region of the country (Anonymous, 2015).

Table 2. Traits of the released mutual silage maize hybrids improved by national public research institutes

Hybrid	Institute/ Partners	Regst. year	FAO Group	Plant Height (cm)	Forage yield ton/ha	ADF (%)	NDF (%)	Dry Matter (%)
SAMADA-07	KATAE /MAIM	2009	750	345-375	80	29	59	34-39
AGA	MAIM / BATEM	2015	750	320-400	79-80	32.2-36.9	52.4-65.8	29.6

SASA-5 silage maize hybrid was developed by BATEM and MAIM. The registration processes of the hybrid is going on and it was expected that this hybrid will be available for farmers in 2019. The yield trial results of the experimental hybrids including SASA-5 variety plus commercial checks that carried out in 2014 were given in Table 3. According to the combined analysis results, statistically significant high genotype by environment interactions were detected ($p<0.01$). This shows the importance of site-specific hybrid selection for a target environment. Forage yield obtained from Antalya location was given in table 3. According to the results the highest forage yield was taken from BURAK check (9202 kg/da) and SASA-5 candidate variety showed a medium level performance in that site.

However this candidate variety was better than KILOWATT commercial check. In a study carried out in Antalya conditions in 2006 and 2007 years (Erdal et al. 2009) mean experiment yield found as 6345 kg/da and 6504 kg/da respectively. Similar experiment results were obtained from our study. Lower yields were recorded at İzmir location when compared to Antalya Location. SASA-5 showed a good performance along with P31Y43 commercial check in İzmir location. In a study, six maize hybrids compared in order to determine effect of different sowing times on the hybrids at İzmir and they received higher forage yield than our study (Geren et al. 2003). Since they used different varieties and agronomic applications (sowing times) might have been effective in these results. Forage yields were changed between 5960.7 kg/da (SASA-73) and 8451.8 kg/da (BURAK) in Maras location (Table 4). SASA-5 have performed well and our candidate variety in 3rd place (7857 kg/da) passed the check mean of 7741 kg/ da. Highest forage yields were obtained at S.Urfa location when compared to other locations. SASA-5 was better than all checks included in the experiment at that location. Combined analysis of four locations showed that SASA-5 mutual silage hybrid had a high yield potential after BURAK check. SASA-5 candidate variety and four commercial checks subjected to a quality analysis and the results were given in Table 3. According to the quality analysis lower NDF values were obtained from SASA-5 when compared one of the highest yielding check variety BURAK. It is reported that 45–50% NDF range is an indicator of a good silage (Alfalfa Workgroup, 1998; Aurivo co-operative, 2014). Therefore 44.5 % NDF value of SASA-5 hybrid shows that SASA-5 was a good silage maize hybrid. Also lower ADF is an important trait for quality silage. SASA-5 and KILOWAT seemed to be good hybrids in terms of ADF values. Similar results can be said for ADL

values. Crude cellulose levels also showed that this hybrid is good enough for digestibility. Also the hybrid is in the middle in terms of dry matter ratio.

Table 3. Ouality analysis of SASA-5 promising hybrid and four commercial checks

Hybrid	NDF (%)	ADF (%)	ADL (%)	Crude Cellulose (%)	Dry matter (%)
SASA-5	44.5	30.0	1.05	12.0	31.5
BURAK	64.0	45.8	5.96	22.3	28.0
SAMADA 07	41.2	34.9	1.07	12.5	34.1
P.31Y43	44.3	42.3	1.27	17.5	34.9
KILOWATT	34.3	26.9	1.18	13.0	35.0
Mean	45.7	36.0	2.10	15.5	32.7

Table 4. Silage maize forage yield (kg/da) trails and combined analysis results

	Locations									
Hybrids	Antalya		İzmir		Maraş		Ş.Urfa		Combined	
SAMADA-07(St)	9201.3	a	2228.3	g	7793.1	ab	8204.7	bc	6856.9	cde
BURAK(St)	8457.3	a	5399.7	abc	8451.8	a	8152.3	bc	7615.3	a
ADA 12.20	7153.7	b	5457.3	abc	7290.3	bcd	8038.0	bc	6984.8	bc
P.31Y43(St)	6712	bc	6333.3	a	7843.7	ab	6895.0	de	6946	bcd
ADA 12.10	6611.7	bcd	3762.0	def	7867.9	ab	8523.7	abc	6691.3	cdef
SASA-5	*6611.0*	*bcd*	*6181.0*	*a*	*7856.6*	*ab*	*9038.0*	*ab*	*7421.7*	*ab*
SASA-11	6551.3	bcd	5523.7	ab	7847.5	ab	6771.3	de	6673.5	cdef
ADA 12.59	6107.7	cde	4628.7	bcde	6431.9	de	7743.0	cd	6227.8	fgh
SASA-73	6061.3	cde	3924	def	5960.7	e	9324.0	a	6317.5	efg
ADA 12.5	6016.7	cde	4095.3	cdef	6375.8	de	6257.0	e	5686.2	hı
KILOWATT(St)	5982.7	cde	5457.3	abc	6873.6	bcde	7743.0	cd	6514.1	cdef
ADA 12.22	5879.7	cdef	5152.0	abcd	7750.8	abc	6771.3	de	6388.4	defg
ADA 12.44	5716.0	def	4990.7	abcde	7002.6	bcde	8304.7	abc	6503.5	cdef
SASA-72	5503.3	ef	2780.7	fg	6423.1	de	7485.7	cd	5548.2	ı
SASA-74	4956.0	f	3714.0	g	6663.8	cde	8404.7	abc	5934.8	ghı
Experiment mean	6501.5		4641.9		7288.9		7843.6		6554	
Check mean	7588.3		4854.7		7740.6		7748.8		6983.1	
LSD	927.71**		1403.3**		1108.8**		1068.5**		561.8**	
CV	8.53		18.1		9.2		8.14		10.6	
			Genotype x Environment **							

**: statistically significant at 1% level

CONCLUSIONS

Cooperation among national public research institutes to develop silage maize hybrids that have good yield and quality potential for Turkey gave good results. The studies is going on and new hybrids will be developed and release for the farmers in the future.

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