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EFFECTS OF DIFFERENT SEED SIZES AND SHAPES ON FORAGE YIELD AND QUALITY OF FODDER MAIZE

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Abstract

The aim of this study was to investigate the effects of different seed sizes and shapes on forage yield and quality of some maize (Zea mays L.) varieties grown under ecological conditions of Aydın. Three hybrid maize varieties (Bolson, Simon, Diptic) seeds were used as material in three different sizes (Small, Medium, Large) and two different shapes (Flat, Round) in the study. In this experiment; plant height, fresh forage yield, dry forage yield, crude protein ratio, ADF, NDF and ADL was measured. After the measurements, crude protein yield, digestible dry matter, relative feed value and relative feed quality was calculated. It was determined that the highest forage yield and quality were found in the Diptic maize variety in the direction of the results obtained from the experiment, it was determined that the highest forage yield and quality were obtained from small seeds in terms of size. As a result of the experiment, it has been determined that the shape and size of the varieties besides the selection of varieties have significant effects on the forage yield and quality.

Key words*: fodder maize, forage quality, seed size, seed shape.*

INTRODUCTION

Forage crops are known to have a positive influence on the physical and chemical properties of the soil and on the yield and quality of the cultivated plants following it, as well as providing the fodder which constitutes one of the most important inputs of animal production (Sürmen, Kara, 2017). Within forage crops, maize is ranked as the third major cereal crop after wheat and rice in world production. Production of maize cultivation area having an important place in Turkey as of 2017, 474,590 ha, the average yield of 4885 kg/ha reached (TUIK, 2018). The crop has a wider range of uses. These include the following: human food, industrial processed food production of starch and used as forage to feed animals. Maize with its large number of cultivars and different maturity periods has wider range of tolerance to different environmental conditions (Purseglove, 1972).
The grain is classified according to its size and shape due to the development of the instructions on the maize cob to the tip. According to the position of the grains on the cob, the small and round seeds are large from the tip of the cob, the rounds are from the bottom of the cob, and the straight seeds are from the middle of the cob (Nielsen, 1996; Chaudhry, Ulah, 2001; Kara, 2008).
This suggests that, except for varietal selection, varieties may produce differences in forage yield and quality in size and shape differences. For this reason, the effects of fodder maize on the yield and quality of seeds of different sizes and shapes are investigated.

MATERIALS AND METHODS

The trial was carried out in the province of Aydın in 2015 and the climate data for the time when the experiment was conducted are given in Table 1.

Three hybrid corn varieties (Bolson, Simon, Diptic) seeds were used as material in two different shapes (Flat, Round) with three different sizes (Small, Medium, Large) in the study. All plots were fertilized as 18 kg/da N and 7 kg/da P_2O_5 (Ergin,1974).
When the plants reached 6-8 leaf turns, intermediate anchor and throat filling operations were performed. Irrigation was carried out 5 times considering the periods of growth and development.

Table 1. Climate data for 2015 and long years of the area where the experiment was conducted

Months	Rainfall (mm)		Avg. Temp. (°C)	
	2015	Long Years	2015	Long Years
January	117.4	126	7.8	8.4
February	166	96	8.7	9.6
March	70.8	71	11.1	11.7
April	5.8	45	14.1	15.9
May	79.6	29	20.9	20.8
June	38.2	14	23.6	24.7
July	2.4	3	27.7	27.8
August	0	3	27.3	27.2
September	29.4	17	24.1	23.7
October	74.4	47	18.7	18.7
November	85.2	74	13.3	14
December	4	139	6.2	10
Total	673.2	664		

Source: ADU Faculty of Agriculure Climate Station for 2015, https://tr.climate-data.org/location/21651/ for long year climate datas.

Formal operations were performed during the lactation period. Herbage yield (kg/da) was measured after harvesting and hay yield (kg/da) was measured by fan drying at 70°C for 48 hours until the weight was fixed (Albayrak et al., 2006).

Crude protein ration (%), ADF (%), NDF (%) and ADL (%) of the samples taken from the experiment was measured by NIRS-FT (Bruker MPA) (Gislum et al., 2004). The crude protein yield (kg/da), digestible dry matter (DDM%), relative feed value (RFV) and relative feed quality (RFQ) were calculated by the obtained data.

The following procedures were used to calculate the relative feed value (Horrocks, Vallentine, 1999; Jeranyama, Garcia, 2004).

DDM% = 88.9 - (0.779 x ADF%) x DMI% (Dry Matter Intake) = 120/NDF%

RFV = (DDM%) x (DMI%) x 0.775

RFQ = (DMI%) x (TDN%)/1.23

In order to compare the results obtained from the study, variance analysis was applied according to randomized blocks trial design with the help of MSTAT-C statistical package program. LSD multiple comparison test was used in comparison of the averages.

RESULTS AND DISCUSSIONS

When the results obtained from the experiment are analyzed, it is seen that the interactions are important in many parameters.

The most remarkable result is that the shape* size interaction is insignificant in terms of relative feed value (Table 2).

Table 2. According to the results of variance analysis, the significance ratings of the parameters

	Parameteres										
İnt.	P.H.	FFY	DFY	CPR	ADF	NDF	ADL	CPY	DDM	RFV	RFQ
Var.	*	*	*	Ins.	**	*	*	*	**	*	*
Shape	Ins.	*	Ins.	Ins.	*	*	Ins.	*	*	*	*
Size	**	*	*	*	**	*	*	*	*	*	*
V*Sh	Ins.	*	*	*	*	*	*	*	*	**	**
V*Si	*	*	*	*	*	*	*	*	*	*	*
Sh*Si	Ins.	*	*	*	Ins.	Ins.	*	*	Ins.	Ins.	Ins.
V*Sh*Si	*	*	*	*	*	*	*	*	*	*	*

*p<0.01, **p<0.05, Ins: Insignificant.

When the results of plant height averages are evaluated, it is seen that the values change between 201.36-225.25 cm.

The highest value was obtained from the seeds of flat and medium sized Simon variety. In terms of varieties average, the highest value is found in Simon variety with 235.95 cm (Table 3). In the researches carried out, average plant height in Bulut (2016), 174-210.5 cm, Akdeniz et al. (2004), 143.7-242.6 cm and Özata et al. (2012), 300.2 cm. The results are generally similar to the experiment.

Table 3. Averages and grouping of plant height (cm)

Plant Height (cm)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	223.60 d	226.13 cd	234.80 b	228.17
	Round	231.53 bc	236.03 b	220.13 de	229.23
	Average	**227.56**	**231.08**	**227.46**	**228.70 b**
Simon	Flat	237.23 b	245.26 a	223.66 d	235.38
	Round	239.16 ab	236.06 b	234.30 b	236.51
	Average	**238.20**	**240.66**	**228.98**	**235.95 a**
Diptic	Flat	210.26 f	210.66 f	211.66 f	210.86
	Round	201.36 g	210.16 f	214.66 ef	208.73
	Average	**205.81**	**210.41**	**213.16**	**209.80 c**
Gen. Ave.		**223.86 b**	**227.38 a**	**223.20 b**	224.81

When we measured fresh average yields, the values were found to be between 2380.95-5283.80 kg/da, the highest value being obtained from round and medium sized seeds of Diptic variety. The highest variety average was 4179.20 kg/da of Diptic variety (Table 4).

In researches, Bulut (2016) was found between 5642-7123 kg/da. This results are higher than the experiment. Özata et al. (2012) were found 4670.2 kg/da, Akdemir et al. (1997) were found between 4834-6706 kg/da. These results are similar to the experiment.

Table 4. Averages and grouping of fresh forage yield (kg/da)

Fresh Forage Yield (kg/da)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	3361.42 h	4379.99 cd	3352.37 hı	3697.93
	Round	4657.61 b	4335.23 cd	3759.04 fg	4250.63
	Average	**4009.52**	**4357.61**	**3555.71**	**3974.28 b**
Simon	Flat	3388.56 h	4159.99 de	3312.37 hı	3620.31
	Round	3551.42 gh	2814.28 j	2380.95 k	2915.55
	Average	**3469.99**	**3487.14**	**2846.66**	**3267.93 c**
Diptic	Flat	3993.33 ef	4000.47 ef	3101.90 ı	3698.56
	Round	4141.42 de	4554.28 bc	5283.80 a	4659.83
	Average	**4067.37**	**4277.37**	**4192.85**	**4179.20 a**
Gen. Ave.		**3848.96 b**	**4040.71 a**	**3531.74 c**	3807.13

Values according to dry weight average ranged from 351.82-1080.68 kg/da and the highest value was obtained from round and small sized seeds of Diptic variety. In the varieties, the highest value was determined with 829.72 kg/da of Diptic variety (Table 5).

In research results, Özata et al. (2012) were found 1455.5 kg/da and Erdal et al (2009) were found 2333 kg/da. These results are higher than the experiment. Akdeniz et al. (2004) were found between 683-1723 kg/da. These results are similar between the experiment.

The mean values of crude protein ratio ranged from 8.15 to 9.64% and the highest crude protein ratio was obtained from round and medium sized seeds of Simon variety. There was no statistical difference between varieties general averages (Table 6). In studies, Erdal et al. (2009) were found 7.5%, Akdeniz et al. (2003) were found between 6.65-6.82%. These results are lower than the study.

Table 5. Averages and grouping of dry forage yield (kg/da)

Dry Forage Yield (kg/da)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	714.24 ef	939.61 b	502.29 gh	718.72
	Round	842.91 bd	594.88 fg	590.05 fg	675.95
	Average	**778.58**	**767.25**	**546.17**	**697.33 b**
Simon	Flat	477.83 gı	836.56 be	772.62 de	695.67
	Round	535.24 gh	451.67 hı	351.82 ı	446.24
	Average	**506.54**	**644.11**	**562.22**	**570.96 c**
Diptic	Flat	900.17 bc	791.23 ce	526.07 gh	739.15
	Round	907.36 bc	1080.68 a	772.80 de	920.28
	Average	**903.76**	**935.95**	**649.43**	**829.72 a**
Gen. Ave.		**729.63 a**	**782.44 a**	**585.95 b**	699.33

Table 6. Averages and grouping of crude protein ratio (%)

Crude Protein Ratio (%)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	8.76 ef	8.62 eg	9.49 ac	8.96
	Round	8.67 ef	8.53 fg	9.30 bc	8.84
	Average	**8.72**	**8.58**	**9.40**	**8.90**
Simon	Flat	9.57 ab	8.91 de	8.15 h	8.88
	Round	8.59 fg	9.64 a	9.34 ac	9.19
	Average	**9.08**	**9.27**	**8.74**	**9.03**
Diptic	Flat	9.20 cd	8.53 fg	8.89 e	8.87
	Round	8.91 de	8.36 gh	9.58 ab	8.95
	Average	**9.05**	**8.44**	**9.23**	**8.91**
Gen. Ave.		**8.95 b**	**8.76 c**	**9.12 a**	8.95

ADF averages ranged from 27.4 to 35.72%, NDF averages ranged from 37.38 to 50.84% and ADL averages ranged from 2.80 to 4.18%. In all three parameters, the lowest values are high quality and the lowest values are obtained from the round and small size seeds of the Diptic variety (Tables 7, 8, 9.). In study about NDF% and ADF%, Özata et al. (2012) were found 53.5%, 32.2%, respectively. The mean values for crude protein yield ranged from 222.55 to 506.54 kg/da, while the highest value was obtained from the round and medium sized seeds of the Diptic variety. The highest value according to the varieties average was determined at the Diptic variety with 373.48 kg/da (Table 10).

Table 7. Averages and grouping of ADF (Acid Detergent Fiber) (%)

ADF (%)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	32.59 bc	28.62 fg	33.39 ab	31.53
	Round	29.13 eg	30.16 cf	33.81 ab	31.03
	Average	**30.86**	**29.39**	**33.60**	**31.28**
Simon	Flat	35.72 a	34.84 ab	28.70 fg	33.08
	Round	27.84 fg	32.42 bc	26.72 g	28.99
	Average	**31.78**	**33.631**	**27.71**	**31.04**
Diptic	Flat	29.87 cf	32.09 be	27.36 fg	29.77
	Round	32.33 bd	29.22 dg	27.11 fg	29.55
	Average	**31.10**	**30.66**	**27.23**	**29.66**
Gen. Ave.		**31.24 a**	**31.22 a**	**29.51 b**	30.66

Table 8. Averages and grouping of NDF (Neutral Detergent Fiber) (%)

NDF (%)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	47.93 ad	48.06 ad	48.42 ac	48.13
	Round	41.70 fg	44.78 df	49.05 ab	45.18
	Average	**44.81**	**46.42**	**48.73**	**46.65 a**
Simon	Flat	50.84 a	48.74 ab	41.87 fg	47.15
	Round	42.33 fg	48.26 ac	39.64 gh	43.41
	Average	**46.58**	**48.50**	**40.76**	**45.28 a**
Diptic	Flat	43.13 ef	43.93 ef	39.37 gh	42.14
	Round	45.92 be	45.01 cf	37.38 h	42.77
	Average	**44.53**	**44.47**	**38.38**	**42.46 b**
Gen. Ave.		**45.31 a**	**46.46 a**	**42.62 b**	44.80

Table 9. Averages and grouping of ADL (Acid Detergent Lignin) (%)

ADL (%)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	4.18 a	3.27 df	3.68 b	3.71
	Round	3.52 bd	3.54 bc	2.98 gh	3.34
	Average	**3.85**	**3.40**	**3.33**	**3.53 a**
Simon	Flat	3.50 bd	2.60 ı	3.52 bd	3.20
	Round	3.53 bd	3.98 a	3.19 fg	3.56
	Average	**3.51**	**3.29**	**3.35**	**3.38 ab**
Diptic	Flat	3.14 fg	3.66 b	3.20 eg	3.33
	Round	3.31 cf	3.45 be	2.80 hı	3.19
	Average	**3.22**	**3.55**	**3.00**	**3.26 b**
Gen. Ave.		**3.53 a**	**3.41 b**	**3.23 c**	3.39

Table 10. Averages and grouping of crude protein yield (kg/da)

Crude Protein Yield (kg/da)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	294.69 hı	377.82 c	318.26 fh	330.26
	Round	403.99 b	370.06 cd	350.02 de	374.69
	Average	**349.34**	**373.94**	**334.14**	**352.47 b**
Simon	Flat	324.28 fg	370.90 cd	270.01 ı	321.73
	Round	305.40 gh	271.29 ı	222.55 j	266.41
	Average	**314.84**	**321.10**	**246.28**	**294.07 c**
Diptic	Flat	367.47 cd	341.54 ef	275.58 ı	328.20
	Round	369.01 cd	380.74 bc	506.54 a	418.76
	Average	**368.24**	**361.14**	**391.06**	**373.48 a**
Gen. Ave.		**344.14 a**	**352.06 a**	**323.83 b**	340.01

The values for digestible dry matter averages ranged from 61.07 to 68.08%, the highest value being obtained from round and small sized seeds of the Simon variety (Table 11).

Relative feed value averages ranged from 111.72-169.66, relative feed quality ranged from 117.20-177.98. Both parameters showed the most economical application in terms of varieties and yields, while these values were obtained from round and small sized seeds of Diptic variety (Tables 12, 13).

It is thought that some studies may have different results because of different seed varieties and cultivation conditions.

Table 11. Averages and grouping of digestible dry matter (%)

Digestible Dry Matter (%)					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	63.51 ef	66.60 ab	62.88 fg	64.33
	Round	66.20 ac	65.40 be	62.55 fg	64.72
	Average	**64.86**	**66.00**	**62.72**	**64.52**
Simon	Flat	61.07 g	61.75 fg	66.54 ab	63.12
	Round	67.20 ab	63.64 ef	68.08 a	66.31
	Average	**64.14**	**62.70**	**67.31**	**64.71**
Diptic	Flat	65.62 be	63.89 cf	67.58 ab	65.70
	Round	63.71 df	66.13 ad	67.78 ab	65.87
	Average	**64.66**	**65.01**	**67.68**	**65.78**
Gen. Ave.		**64.55 b**	**64.57 b**	**65.90 a**	65.01

Table 12. Averages and grouping of relative feed value

Relative Feed Value					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	123.37 eh	128.92	120.84 gh	124.38
	Round	148.01 bc	136.02 cf	118.78 gh	134.27
	Average	**135.69**	**132.47**	**119.81**	**129.32 b**
Simon	Flat	111.72 h	118.55 gh	148.14 bc	126.13
	Round	147.87 bc	122.64 fh	159.74 ab	143.42
	Average	**129.79**	**120.59**	**153.94**	**134.78 b**
Diptic	Flat	141.60 cd	135.40 cf	159.80 ab	145.60
	Round	129.43 dg	136.95 ce	169.66 a	145.35
	Average	**135.52**	**136.18**	**164.73**	**145.48 a**
Gen. Ave.		**133.67 b**	**129.75 b**	**146.16 a**	136.53

Table 13. Averages and grouping of relative feed quality

Relative Feed Quality					
Varieties	Shape	Size			Gen. Ave.
		Large	Medium	Small	
Bolson	Flat	129.43 eh	135.25 dg	126.77 gh	130.48
	Round	155.26 bc	142.69 cf	124.61 gh	140.85
	Average	**142.35**	**138.97**	**125.69**	**135.67 b**
Simon	Flat	117.20 h	124.36 gh	155.40 bc	132.32
	Round	155.12 bc	128.66 fh	167.58 ab	150.45
	Average	**136.16**	**126.51**	**161.49**	**141.39 b**
Diptic	Flat	148.55 cd	142.04 cf	167.64 ab	152.74
	Round	135.78 dg	143.67 ce	177.98 a	152.48
	Average	**142.16**	**142.86**	**172.81**	**152.61 a**
Gen. Ave.		**140.22 b**	**136.11 b**	**153.33 a**	143.226

CONCLUSIONS

One of the important roughage sources today is the maize, which is the day that the forage crops importance is increasing day by day. corn is an annual and high-yielding plant. Variety selection in maize production has an important place. Besides the selection of varieties, seeds with different shapes and sizes can have an effect on yield and quality. According to the results of the research, it has been seen that the varieties, shapes and sizes yield and quality

values are different. Especially Diptic variety and small and round seeds of this variety have the highest feed value in the direction of the results obtained from the experiment.

These results also showed that the shape and size differences affect the yield and quality of feed significantly.

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