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Performances of Hybrid Dent Maize Cultivars in Bingöl Conditions

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Abstract: The research was conducted with aim to investigate adaptation capability of twenty five hybrid dent corn cultivars, and to determine relationships among traits in maize at Bingol, East Anatolia Region, conditions of Turkey during 2014 and 2015 growing seasons. The experiment was set up according to the Randomized Complete-Block Design with three replicates. Results of the research showed that differences among the grain yields and yield components of cultivars were statistically significant in both years. The highest and the lowest value of yield components varied according to cultivars and years. The grain yield of maize cultivars varied in between 5521.3-10442.0 kg ha^{-1} in the first year and in between 6362.0-14296.7 kg ha^{-1} in the second year. The highest grain yields were determined in ADV-2898 cultivar (10442.0 kg ha^{-1}) in the first year and Tuano cultivar (14296.7 kg ha^{-1}) in the second year. The lowest grain yield was identified in Şafak cultivar (5521.3 kg ha^{-1}) in the first year and Dian cultivar (6362.0 kg ha^{-1}) in the second year. According to correlation analysis, grain yield was positively and significantly correlated with ear length, ear diameter number of kernel per ear, ear weight and 1000 grain weight of maize. The non-significant correlations were determined in between grain yield with plant height and stem diameter.

Bingöl Koşullarında Hibrit Atdişi Mısır Çeşitlerinin Performansları

Anahtar Kelimeler
Mısır,
Çeşit,
Verim,
Korelasyon

Özet: Araştırma 2014 ve 2015 yıllarında Türkiye'nin Doğu Anadolu Bölgesinde yer alan Bingöl şartlarında 25 atdişi hibrit mısır çeşidinin adaptasyon kapasitesini araştırmak ve incelenen özellikler arasındaki ilişkileri belirlemek amacıyla yürütülmüştür. Çalışma tesadüf blokları deneme desenine göre üç tekerrürlü olarak kurulmuştur. Araştırmanın sonuçlara göre her iki yılda da çeşitlerin verim ve verim özellikleri arasındaki farklar istatistiksel olarak önemli olmuştur. İncelenen verim özelliklerinin en yüksek ve en düşük değerleri çeşitlere ve yıllara göre değişmiştir. Mısır çeşitlerinin tane verimleri birinci yıl 552.13-1044.20 kg/da, ikinci yıl 636.20-1429.67 kg/da arasında değişmiştir. En yüksek tane verimi birinci yıl ADV-2898 çeşidinde (1044.20 kg/da), ikinci yıl Tuano çeşidinde (1429.67 kg/da) belirlenmiştir. En düşük tane verimi ise birinci yıl Şafak çeşidinde (552.13 kg/da), ikinci yıl Dian çeşidinde (636.20 kg/da) kaydedilmiştir. Korelasyon analiz sonuçlarına göre, mısırda tane verimi ile koçan boyu, koçan çapı, koçanda tane sayısı, koçan ağırlığı ve 1000 tane ağırlığı arasında pozitif ve önemli ilişkiler belirlenmiştir. Tane verimi ile bitki boyu ve sap çapı arasındaki ilişki önemli çıkmamıştır.

1. Introduction

In Turkey, in the previous years, an average yield of maize was significantly under of important countries growing maize. However, recent years (the last 10-15 years) maize average yield of Turkey significantly increased, and maize is cultivated on an area of 658.645 hectares, with an annual production of 5.9 million tons and an average yield of 9.03 t ha^{-1} [1]. The average corn yield per hectare of Turkey is close in compared to other important countries growing maize including France (10.03 t ha^{-1}), Germany (10.68 t ha^{-1}), Austria (10.79 t ha^{-1}) and USA (10.73 t ha^{-1}) [2].

The maize is the third most-produced crop after wheat and barley in term of production in Turkey. In recent years, the important of maize being increased due to animal feeding, bio-oil and nutritive industry depending on high grain and biomass yield [3]. The increases in the maize production result from mainly hybrid varieties in Turkey. In addition, maize

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production can be increased due to bias may be genetically modified organism of maize imported from USA and Europe countries. Generally, the hybrid cultivars have sown in Cukurova, Mediterranean and Southeastern Anatolia regions because of favorable climatic conditions. The hybrid cultivars not enough have sown in the Black Sea and Eastern Anatolia regions. Therefore, maize grain yield lowed in these regions. There are many studies on adaptation of hybrid maize varieties in Turkey, but, there aren't enough information and research on hybrid maize cultivars in the Eastern Anatolia regions. The Eastern Anatolia regions is a region where mainly livestock (sheep, goats and cows). Therefore, maize production is significant as green forage, industrial feed (seed) and silage in the Eastern Anatolia regions. Many researchers reported that grain yield and yield components of hybrid dent maize varieties varied according to genetic traits of cultivars, soil and climatic conditions, and agronomic characteristics [4-8].

The correlation analysis could be used determining the relationship between yield and yield related traits. The correlation coefficients generally show relationships among independent variables. Dash et al. [8] stated that the most positive effect on grain yield was plant height, ear length and 1000 grain weight. Torun and Köycü [10] reported that number of kernels per ear and ear length had a significant effect, while plant height had no significant effect on grain yield, and plant height had a negative indirect effect on grain yield. Şekeroğlu et al. [11] recorded that the grain yield was positively correlated with all the character investigated.

The aim of the study was to investigate adaptation capability of twenty five hybrid dent corn cultivars at Bingöl conditions, and to determine relationships among traits in maize.

2. Materials and Methods

The experiment was conducted at Bingöl conditions, East Anatolia Region, of Turkey in 2014 and 2015 years. The experiment was set up according to the Randomized Complete-Block Design with three replicates. The hybrid dent corn (*Zea mays indendata* L.) cultivars used in the research is shown at Table 1.

The experiment area was tilled with plough pan and prepared by pulling of cultivator on soils. The plot size was 2.8m x 8m= 22.4 m^2 and consisted of 4 rows. The experiments were set up in the first week of May in both years. Seeds were sown at 5-6 cm depths using a dibbler in 70 cm x 20 cm row spaces. Fertilizers were applied to the rows at the rate 250 kg ha^{-1} ammonium sulphate and 100 kg ha^{-1} triple super phosphate as pure. The total quantity of phosphorus was applied at the time of sowing and nitrogen was applied in two equal amounts at the time of sowing, 10 cm seedling height and 35-40 cm height stages. The irrigation was watered using a drip system.

2.1. Climatic data of the experimental area

Bingöl province has 1050 m altitude. Bingöl has terrestrial climatic character in the East Anatolia region. Climatic data of experiment area in growing season is shown at Table 2. The average temperature from May to September was 23.1 °C, and total rainfall was 157.7 mm in 2014 year. The same period for 2015 year average temperature was 23.6 ^{0}C, and rainfall was 30.7 mm (Table 2).

Table 1. The cultivars used in experiments and their obtained companies / Institute

Cultivars	Companies	FAO group
31P41	Pioneer Seeds	-
30B74	Pioneer Seeds	-
31Y43	Pioneer Seeds	600
31A34	Pioneer Seeds	-
R.U 4 H.D	Pioneer seeds	600
12-219	Panam France Seed Company	610
12-218	Panam France Seed Company	610
12-231HO	Panam France Seed Company	630
Dian	Panam France Seed Company	590
Marvin	Panam France Seed Company	590
Eldora	Panam France Seed Company	590
DKC-955	Monsanto Company	800
DKC-6903	Monsanto Company	700
DKC-6589	Monsanto Company	650
DKC-7211	Monsanto Company	750
DKC-6590	Monsanto Company	700
Wayne	Italy Venturoli	700
Şafak	BATEM	700
Batem efe	BATEM	700
Burak	BATEM	700-750
Seme Kukuruza 877	Serbia	700
Seme Kukuruza 873	Serbia	700
ADV-2898	Limagrain seeds	-
Truva	Limagrain seeds	-
Tuano	Beta agriculture	600

2.2. Soil structure

Soil in a depth of 60 cm was sampled before the start of the experiment. Soil was lowed in organic matter (1.26%), medium acid in (pH: 6.37), low in calcium carbonate (0.15%) and high in P (79.1 kg ha^{-1} P_2O_5) and low amount of in K_2O (24.5 kg ha^{-1}) contest.

2.3. Yield and its components

When the kernel moisture was about 15% in each cultivar, two rows in the center of each plot were harvested, manually, in between 15-30 September according to cultivar characteristics. Then, the grains are dried under sun until the moisture content falls below 13%. N content was determined by using Kjeldahl method. The plant height, stem diameter, grain yield and yield components including ear diameter, ear length, number of kernels per ear, ear weight and 1000 kernel weight were determined as describe by Gokmen et al, 2001. Grain yield was calculated by multiplying by 10000/plot sizes/m^2.

All the data were analyzed with analysis of variance (ANOVA) using SPSS Statistical Package Program. Means were compared using the DUNCAN test.

3. Results and Discussion

In the research, differences in between the years were statistically significant in all the characters. Data of the first year was higher than in the second year, except for plant height. Results of the research showed that differences among the cultivars in term of grain yield, plant height, stem diameter and yield components including ear length, ear diameter, number of kernels per ear, ear weight and 1000 kernel weight were statistically significant in both years. The highest and the lowest value belonging to plant height, stem diameter, ear length, ear diameter, number of kernels per ear, ear weight and 1000 kernel weight of maize cultivars varied according to cultivars and years. The grain yield of maize cultivars varied in between 5521.3-10442.0 kg ha^{-1} in the first year and in between 6362.0-14296.7 kg ha^{-1} in the second year in Bingöl conditions that terrestrial climatic character. The highest grain yield was determined in ADV-2898 cultivar (10442.0 kg ha^{-1}) in the first year and Tuano cultivar (14296.7 kg ha^{-1}) in the second year. The lowest grain yield was identified in Şafak (5521.3 kg ha^{-1}) in the first year and Dian (6362.0 kg ha^{-1}) in the second year. Batem Efe cultivar followed to ADV-2898 and Tuano cultivars in both years. Generally, ear length, ear diameter, number of kernels per ear, ear weight and 1000 kernel weight of ADV-2898, Tuano and Batem Efe cultivars were higher the others cultivars (Table 3). In conducted studies in different regions of Turkey, hybrid dent maize grain yield were between 8110-1636 kg ha^{-1} in Harran plain [5], 7910-13322 kg ha^{-1} in Kahramanmaras conditions [12], 7259-8996 kg ha^{-1} in Manisa conditions [13], 6500–10370 kg ha^{-1} in Konya conditions [14], 8912-13120 kg ha^{-1} in Amik plain conditions [15], 9300-15110 kg ha^{-1} in Adapazarı, 7840-12910 kg ha^{-1} in Adana and 9100-12190 kg ha^{-1} in Samsun conditions [6]. In compared with the above researches, we can say that commercial maize production can be done in Bingöl conditions. The differences in grain yield among cultivars can be result from variety characteristics, genetic traits, root length, nutrient uptake, maturity periods of cultivars, climatic factors and agricultural practices [12, 14-19].

According to correlation analysis results of maize, there is high positive correlation between grain yield with ear length, ear diameter, number of kernel per ear, ear weight and 1000 grain weight. The highest significant positive correlation (0.925**) was observed in between grain yield and ear weight. The non-significant correlations were determined in between grain yield with plant height and stem diameter. There were negative correlations in between ear diameter with plant height and stem diameter (Table 4). This result was parallel with the finding of Sekeroglu et al. [10] stated that the grain yield was positively correlated with plant height, ear length, ear diameter, number of kernels per ear and 1000 kernel weight. Another study reported that the number of kernels per ear and ear length had a significant direct effect, while plant height had no significant effect on grain yield [9].

4. Conclusion

In the research, grain yield and yield components including ear length, ear diameter, number of kernels per ear, ear weight and 1000 kernel weight varied according to cultivars and years. The grain yield varied in between 5521.3-10442.0 kg ha-1 in 2014 and 6362.0-14296.7 kg ha-1 in 2015 in Bingöl conditions. Among the cultivars, the highest grain yields were obtained from ADV-2898, Tuano and Batem Efe cultivars in the Bingöl conditions.

Correlation coefficients showed that there was positive correlation between grain yield with ear length, ear diameter number of kernel per ear, ear weight and 1000 grain weight, while the non-significant correlations were determined in between grain yield with plant height and stem diameter.

As a result, 1- It is possible to say that commercial maize production can be done in Bingöl conditions. 2- We could advise ADV-2898, Tuano and Batem Efe cultivars because of its higher yields in the Bingöl conditions. 3- According to correlation analysis results, between the grain yield and ear weight was the highest positive and significant relation in maize.

Table 2. Climatic data of the experiment area in growing season*

Climatic factors	Years	May	June	July	August	September	Mean/Total
Mean Temperature (°C)	2014	17.2	22.3	27.4	27.7	21.0	23.1
	2015	16.6	22.9	27.9	27.5	23.4	23.6
	Long years	16.2	22.3	26.8	26.4	21.0	22.5
Precipitation (mm)	2014	63.2	25.9	4.0	0.9	63.7	157.7
	2015	21.2	8.1	-	0.6	0.8	30.7
	Long years	74.8	21.0	6.1	4.4	13.7	120.0

* Bingöl Meteorology Station

Table 3. Grain yield and yield components of hybrid dent maize cultivars across growing seasons

Cultivars	Plant height (cm)		Stem diameter (mm)		Ear length (cm)		Ear diameter (mm)	
	2014	2015	2014	2015	2014	2015	2014	2015
31P41	223.8 c-g	213.8 b	22.7abc	21.2abc	16.5a-d	14.5 k	42.0c-g	35.6 m
30B74	273.5 a	260.5 a	29.6 a	24.0abc	14.3 d	19.0 bc	37.0jkl	39.6 kl
31Y43	234.7 b-e	226.3 ab	22.2abc	24.1abc	16.9a-d	16.6 hı	39.1h-k	39.0 kl
31A34	218.5 d-ı	228.2 ab	21.0 bc	24.2abc	16.8a-d	15.8 ıj	41.1c-h	41.0h-k
12-219	238.6 bc	208.3 b	19.7 bc	24.4abc	15.3bcd	18.9bcd	39.0h-k	43.1d-g
12-218	228.7 b-f	210.5 b	19.8 bc	23.3abc	15.8bcd	18.4c-f	36.3 kl	40.7ı-l
12-231H0	216.5 e-ı	201.3 b	21.6 bc	22.7abc	14.7 cd	16.8ghı	40.3e-ı	40.3jkl
DKC-955	237.1 bcd	211.7 b	21.5 bc	23.6abc	16.5a-d	17.6e-h	39.7g-j	42.9d-g
DKC-6903	218.4 d-ı	216.0 b	18.2 bc	21.7abc	15.8bcd	14.4 kl	41.0c-h	40.6ı-l
DKC-6589	201.2 hı	216.1 b	20.1 bc	26.9abc	14.5 d	13.2 l	42.6b-f	43.6b-e
DKC-7211	230.4 b-f	212.5 b	19.4 bc	23.5abc	15.5bcd	17.7d-h	39.6g-j	41.3g-k
DKC-6590	212.9 h-ı	208.2 b	18.3 bc	21.9abc	15.2 cd	17.5fgh	46.0 a	42.7e-h
R.U 4 H.D	218.8 d-ı	197.5 b	21.6 bc	22.5abc	15.8bcd	17.9c-g	43.7abc	43.3c-f
Dian	199.5 ı	196.5 b	17.4 c	20.8abc	15.7bcd	14.5 k	42.1c-g	40.2jkl
Marvin	207.3 ghı	193.0 b	19.6 bc	21.6abc	16.0bcd	17.5fgh	43.6abc	43.0d-g
Eldora	216.3 h-ı	201.6 b	18.7 bc	19.9abc	16.8a-d	14.9 jk	42.7b-f	43.4c-f
Wayne	230.3 b-f	204.7 b	23.2abc	24.3abc	15.7bcd	15.8 ıj	43.0b-e	46.3 a
Şafak	235.2 b-e	213.7 b	25.6 ab	26. 7 a	14.8 cd	18.3c-f	38.0ıjk	39.0 l
Batem efe	244.2 b	217.3 b	24.1abc	24.5abc	18.0 ab	17.4fgh	40.6d-ı	45.3 ab
Tuono	244.4 b	228.3 ab	22.1abc	21.8abc	17.3abc	20.1 ab	42.5b-f	46.0 a
Burak	243.7 b	212.6 b	24.0abc	26.4ab	16.4bcd	20.7 a	34.3 l	45.7 a
S. Kukuruza 877	216.1 e-ı	203.5 b	20.2 bc	23.6abc	15.4bcd	18.8cde	43.3a-d	45.0abc
S. Kukuruza 873	219.6 c-h	206.0 b	19.2 bc	24.3abc	16.6a-d	18.5c-f	40.0f-ı	42.6e-h
ADV-2898	214.9 h-ı	211.0 b	22.1abc	22.3abc	19.2 a	19.1 bc	45.3ab	44.6a-d
Truva	225.3 b-g	219.7 b	21.8 bc	22.4abc	16.7a-d	16.8ghı	41.6c-h	42.3e-ı
Years	226.1 A	212.7 B	21.4 B	23.3 A	16.1 B	17.2 A	40.9 B	42.4 A
Mean square	773.04	552.91	31.05	21.08	14.64	10.60	22.81	18.34
F value	9.89**	5.04*	5.67*	4.34*	6.36*	31.84**	13.46**	29.85**
C.V (%)	3.91	7.74	16.63	10.57	7.70	4.34	3.17	4.84

Cultivars	Num. of kernels per ear (grain)		Ear weight (g)		1000 kernel weight (g)		Grain yield (kg ha^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015
31P41	456.3b-g	354.0 lm	136.0e-ı	125.0 no	328.3abc	339.0c-f	8295.4d-ı	7907.3 l
30B74	526.0abc	550.7 b	189.3 a	199.7bcd	308.3a-d	358.7abc	8705.2c-g	11590.3cde
31Y43	437.0e-h	467.3d-g	118.7ı-m	137.0 mn	315.0abc	314.7 ı-l	7203.3h-k	8793.7 ı-l
31A34	361.0hıj	416.3ıjk	113.0j-n	142.0lmn	300.0b-e	335.3e-h	6674.1j-m	8473.3jkl
12-219	422.3fgh	461.0d-ı	110.7lmn	167.0f-ı	270.0cde	349.6cde	6383.2klm	10162.0fgh
12-218	436.3e-h	461.3d-ı	112.0k-n	160.7g-k	274.7cde	338.3c-g	6658.8j-m	10215.7fgh
12-231H0	491.7a-f	515.7 bc	130.0f-k	162.3g-j	250.7 de	97.0klm	7709.3g-j	9893.3ghı
DKC-955	415.0 f-ı	499.0cde	128.1g-k	156.3ı-l	325.0abc	311.3ı-m	7101.0ı-l	10035.7ghı
DKC-6903	455.3b-g	421.0h-k	128.0g-k	138.3 mn	318.3abc	305.7ı-m	7804.0f-j	9206.0 h-k
DKC-6589	426.3e-h	383.6 kl	129.3f-k	138.0 mn	280.0cde	318.0g-j	8087.3e-ı	8527.7 jkl
DKC-7211	546.0 a	411.3jk	144.7d-g	146.7j-m	278.3cde	338.0d-g	8764.3c-g	8203.0 kl
DKC-6590	530.3 ab	476.0c-g	158.0bcd	175.0e-h	268.3cde	352.6b-e	9747.0abc	10749.3efg
R.U 4 H.D	449.0c-g	444.7f-j	152.7cde	159.0h-l	318.0abc	357.7a-d	8798.0c-g	9528.0 g-j
Dian	445.3d-g	338.3 m	130.7f-j	108.7 o	276.0cde	296.3 lm	8367.3d-h	6362.0 m
Marvin	517.0a-d	499.3cde	150.3cde	154.3ı-m	269.0cde	291.3 m	8968.3b-f	10385.7e-h
Eldora	531.3 ab	442.0g-j	140.3d-h	143.7klm	242.3 e	308.7ı-m	8582.3c-g	8825.3 ı-l
Wayne	401.3ghı	462.3d-h	125.3h-k	168.3f-ı	274.0cde	317.3h-k	7135.3ı-l	10171.7fgh
Şafak	385.3g-j	455.0e-j	98.0 n	141.7lmn	295.7b-e	305.6ı-m	5521.3 m	8381.0jkl
Batem efe	489.3a-f	596.7 a	157.7 cd	208.3abc	320.3abc	337.0e-h	9467.0a-d	13283.3ab
Tuono	542.3 a	560.0 ab	164.0 bc	225.3 a	320.0abc	374.0 a	10094.7ab	14296.7 a
Burak	316.3 j	456.3e-j	98.7 n	192.3cde	344.0ab	345.0c-f	5940.7lm	11392.3def
S. Kukuruza 877	431.3e-h	503.3 cd	147.0 c-f	215.0 ab	316.7abc	370.3ab	9096.7b-e	12682.0bc
S. Kukuruza 873	434.7e-h	488.2c-f	118.6ı-m	178.0efg	245.7 e	325.3f-ı	6734.3j-m	10675.7efg
ADV-2898	502.0a-e	447.3f-j	176.3 ab	182.3def	368.0 a	341.3c-f	10442.0 a	12241.0bcd
Truva	343.7 ıj	502.3 cd	101.3mn	157.3h-l	288.0b-e	298.3j-m	5600.3 m	9474.3 g-k
Years	451.7 B	464.5 A	134.3 B	163.3 A	295.7 B	329.1 A	7915.3 B	10058.2 A
Mean square	11776.92	10720.2	1697.0	2456.28	3011.35	1142.94	5754037.5	9881118.8
F value	9.35**	25.23**	24.0**	36.45**	3.89**	20.19**	18.49**	28.81**
C.V (%)	7.85	4.43	6.25	5.02	9.40	5.82	7.04	6.90

Means in the same columns followed by the same letters are not significantly different as statistically, **, *: significant at P<0.05 and P<0.01 probability levels, respectively

Table 4. Correlation coefficients of yield and some yield components in maize

Yield characteristics	Grain yield	Plant height	Stem diameter	Ear length	Ear diameter	Num. of ker. per ear	Ear weight
Plant height	0.144^{ns}	1.000					
Stem diameter	0.037^{ns}	0.526**	1.000				
Ear length	0.489**	0.240*	0.254*	1.000			
Ear diameter	0.573**	-0.293*	-0.195^{ns}	0.175^{ns}	1.000		
Num. of ker. per ear	0.729**	0.230*	0.067^{ns}	0.357**	0.304**	1.000	
Ear weight	0.925**	0.277*	0.186^{ns}	0.504**	0.488**	0.759**	1.000
1000 grain weight	0.491**	0.289*	0.153^{ns}	0.517**	0.135^{ns}	0.077^{ns}	0.488**

*, **: significant at P<0.05 and P<0.01 probability levels, respectively, ns: non-significant

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