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.
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 lowered 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 Kocyü [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. Şekeroglu 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 indedanta 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 m² 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 °C, and rainfall was 30.7 mm (Table 2).

| Cultivars     | Companies           | FAO group |
|---------------|---------------------|-----------|
| 31P41         | Pioneer Seeds       | -         |
| 30874         | Pioneer Seeds       | -         |
| 31Y43         | Pioneer Seeds       | 600       |
| 31A34         | Pioneer Seeds       | -         |
| RJ 4 H.D      | Pioneer seeds       | 600       |
| 12-219        | Panam France Seed Company | 610   |
| 12-218        | Panam France Seed Company | 610   |
| 12-231H0      | 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       |
| Īzmir         | BATEM               | 700       |
| Seime Kukuruza 877 | Serbia   | 700       |
| Seime Kukuruza 873 | Serbia   | 700       |
| ADV-2898      | Limagrain seeds     | -         |
| Truva         | Limagrain seeds     | -         |
| Tuano         | Betaagriculture     | 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 P₂O₅) and low amount of in K₂O (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/m².
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 than 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 Adapazari, 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 Sekeroğlu 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 |
| Long years | 2014 | 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 |
| Long years | 2014 | 21.2 | 8.1 | - | 0.6 | 0.8 | 30.7 |

* 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 b            | 213.8 b            | 22.7 abc         | 21.2 abc          | 16.5 a            | 14.5 k             | 42.0 c             | 35.6 m             |
| 30B74           | 273.5 a            | 260.5 a            | 29.6 a           | 24.0 abc          | 14.3 d            | 19.0 bc            | 37.0 jk            | 39.6 li             |
| 31Y43           | 234.7 h            | 226.3 ab           | 24.1 abc         | 16.9 a            | 13.6 a            | 39.1 k             | 39.0 li             |
| 31A34           | 218.5 d            | 228.2 ab           | 21.0 bc          | 24.2 abc          | 16.8 a            | 15.8 i             | 41.1 c             | 40.6 k             |
| 12-21           | 238.6 bc           | 208.3 b            | 19.7 bc          | 24.4 abc          | 15.3 bcd          | 18.9 bcd           | 39.0 h             | 43.1 d             |
| 12-218          | 228.7 b            | 210.5 b            | 19.8 bc          | 23.3 abc          | 15.8 bcd          | 18.4 cf            | 36.3 k             | 40.7 l             |
| 12-231H0        | 216.5 e            | 201.3 b            | 21.6 bc          | 22.7 abc          | 14.7 cd           | 16.8 g             | 40.3 i              | 40.3 k             |
| DKC-955         | 237.3 bcd          | 211.5 b            | 23.6 abc         | 23.6 b            | 17.6 ab           | 39.7 j             | 42.9 g             |
| DKC-6903        | 218.4 d            | 214.0 b            | 18.2 bc          | 21.7 abc          | 15.8 bcd          | 14.4 cd           | 41.0 c            | 40.6 l             |
| DKC-6589        | 201.2 hi           | 216.1 b            | 20.1 bc          | 26.9 abc          | 14.5 d            | 13.2 l             | 42.6 f              | 43.6 e             |
| DKC-7211        | 230.4 f            | 208.2 b            | 19.4 bc          | 23.5 abc          | 17.7 b            | 39.6 j            | 41.3 k              | 43.6 e             |
| DKC-593         | 212.9 b            | 208.2 b            | 19.4 bc          | 21.9 abc          | 15.2 bc           | 46.0 a             | 42.7 e             |
| RJ4 H.D        | 219.6 b            | 197.5 b            | 21.6 bc          | 22.5 abc          | 15.8 bcd          | 17.9 c            | 43.7 abc            | 43.3 c             |
| Dian            | 199.5 i            | 196.5 b            | 17.4 c           | 20.8 abc          | 15.7 bc           | 42.1 c             | 42.0 k             |
| Marvin          | 207.3 gh           | 193.0 b            | 19.6 bc          | 21.6 abc          | 16.0 bcd          | 17.5 g             | 43.6 abc            | 43.0 d             |
| Eldora          | 213.6 h            | 201.6 b            | 18.7 bc          | 19.9 abc          | 16.8 abd          | 14.9 jk            | 42.7 f             |
| Wayne           | 230.3 f            | 204.7 b            | 23.2 abc         | 24.3 abc          | 15.7 bcd          | 15.8 i             | 43.0 e             | 46.3 a             |
| Şafak           | 235.2 e            | 213.7 b            | 25.6 ab          | 26.7 a            | 14.8 cd           | 18.3 cf           | 38.0 jk            |
| Batem efe       | 244.2 b            | 217.3 b            | 24.1 abc         | 24.5 abc          | 18.0 ab           | 17.4 ghi          | 40.6 idi            | 45.3 ab             |
| Tsoso           | 244.4 b            | 228.3 ab           | 21.4abc          | 21.8 abc          | 17.3abc          | 20.1 ab            | 42.5 f             |
| Barak           | 243.7 b            | 212.6 b            | 24.0 abc         | 26.4 aba          | 16.3 ab           | 34.3 l             | 45.6 a             |
| S. Kukuruza 873 | 216.1 e            | 203.5 b            | 20.2 bc          | 23.6 abc          | 15.4 bcd          | 18.3 cd           | 43.3 d             |
| S. Kukuruza 873 | 219.6 c            | 206.0 b            | 19.2 bc          | 24.3 abc          | 16.6 a            | 18.5 cf           | 40.0 i              | 42.6 e             |
| ADV-2989        | 214.9 h            | 214.6 b            | 22.1 abc         | 22.3 abc          | 19.2 a            | 19.1 bc           | 45.3 ab              | 44.6 d             |
| Truva           | 225.3 b            | 219.7 b            | 21.8 bc          | 22.4 abc          | 16.7 ab           | 16.8 gh            | 41.6 c             | 43.2 e             |
| Years           | 226.1 A            | 212.7 B            | 21.4 B           | 25.3 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**

CV (%) 3.91 7.74 16.63 10.57 7.70 4.34 3.17 4.84

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

| Yield characteristics | Grain yield | Plant height | Plant stem | Ear length | Ear diameter | Num. of kernel per ear | Ear weight |
|-----------------------|-------------|--------------|------------|------------|--------------|------------------------|------------|
| Plant height          | 0.144**     | 1.00         | 0.64**     | 1.00       |              |                        |            |
| Stem diameter         | 0.037**     | 0.526**      | 1.00       | 0.64**     | 1.00         |                        |            |
| Ear length            | 0.489**     | 0.240*       | 0.254*     | 1.00       |              |                        |            |
| Ear diameter          | 0.573**     | -0.293**     | -0.195**   | 0.175**    | 1.00         |                        |            |
| Num. of ker. per ear  | 0.729**     | 0.230*       | 0.067**    | 0.357**    | 0.304**      | 1.00                   |            |
| Ear weight            | 0.925**     | 0.277*       | 0.186**    | 0.504**    | 0.488**      | 1.00                   | 0.759**    |
| 1000 grain weight     | 0.941**     | 0.289*       | 0.153**    | 0.517**    | 0.135*       | 0.77**                 | 0.468**    |

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.
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