INNOVATIVE APPROACHES IN MEADOW-RANGELAND AND FORAGE CROPS

Editor: Assoc. Prof. Dr. Seyithan SEYDOSOGLU
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CHAPTER 17

INVESTIGATION OF THE POSSIBILITIES OF USING SOME CORN VARIETIES AS SILAGE
INTRODUCTION

Maize plant ranks third in the world in terms of cultivation area, after wheat and paddy, and first in terms of production amount. In the USA, which is the world's largest maize producer, 56% of the production is used as animal feed (Tansı et al., 2009).

Maize has become the most important silage plant due to reasons such as the high rate of green yields per unit area, its suitability for silage production, and the high nutritional value and taste of the obtained silage (Açıkgöz, 2001).

According to the statistics of 2018, it has been reported that silage maize is grown in 1 170 832 hectares in the world and the yield per ha is 9 836 kg (FAO, 2018). According to data of 2018 in Turkey 4,610,436 acres of silage maize is grown. It has been recorded that the yield per decare is 5 032 kg (TUIK, 2018).

In a study conducted in Van ecological conditions regarding the silage yield and yield characteristics of the maize plant, the average plant height was 350 cm, the green leaf rate 17.8%, the stem rate 45.1%, the cob rate 37.1%, forage yield 6586 kg da⁻¹ and dry matter yield 1796 kg da⁻¹ has been determined (Yıldız and Erdoğan, 2018). In the ecological conditions of Antalya province, the average plant height for silage maize was determined as 234 cm, leaf and stem ratio 46.8%, cob rate 35%, forage yield 6345 kg da⁻¹ and dry matter yield 2333 kg da⁻¹ (Erdal et al., 2009). In a study conducted in the ecological conditions of Erzurum province, the plant height of silage maize was determined as 246.9 cm, the rate of cob was 28.6%, and the silage yield was 6233 kg da⁻¹ (Güney et al., 2010). In the ecological conditions of İzmir province,
the yield of maize varieties for silage was determined as 8423 kg da\(^{-1}\) and dry matter yield 2010 kg da\(^{-1}\) (Geren et al., 2003).

It is possible to successfully grow maize for silage in every region of our country. However, it is possible to determine which variety gives better yield for which region by local trials. In this direction, this study was carried out in the growing period of 2020 in order to determine the silage yield and yield characteristics of 6 maize in Bingöl.

**MATERIAL and METHODS**

In this study, 6 maize varieties (Es armandi, DKC 5741, Sygenta atomic, LG 30.500, LG 31.545, LG 30.597) were used as material. The FAO values of these varieties vary between 500 and 640 and they are in the early, middle-early group.

The experiment of the study was conducted in Bingöl University Genç Vocational School Application and Research Area. The average altitude of the Bingöl province Genç district is 997 m above sea level and has a warm and temperate climate. The annual average temperature of Genç district is 13.3 °C, and the annual average total rainfall is 765 mm (Figure 1).

![Figure 1. Annual average temperature and total annual precipitation amount of Bingöl province Genç district (Anonymous, 2020)](image-url)
The soil structure of the research area is sandy-clayey-loam, slightly alkaline, slightly salty, low lime, high in potassium, and low in organic matter and phosphorus (Çaçan and İşikten, 2019).

The trial of the study was established on April 21, 2020, according to the randomized blocks trial pattern, in three replications. The plot lengths are 5 m, the row spacing is 70 cm, and the distance above the row is 15 cm (Anonim, 2018). With sowing, 15 kg nitrogen and 8 kg phosphorus were given as pure substance per decare (Çaçan and İşikten, 2019). All of the phosphorus and one-third of the nitrogen was given with sowing, one-third of the remaining nitrogen with throat filling when the plants reached 40-50 cm, and the remaining third at the tassel removal stage. The harvest was made on August 25, 2020. Plant height and first stem height were measured by meter on 5 plants taken from each plot and repetition. Stem diameter was measured with a hand caliper. Green leaf ratio, green stem ratio, green cob ratio, and forage yield were also obtained by weighing. Dry matter yield was calculated with the dry matter rate obtained after the plants were dried at 70 °C for 48 hours (Seydoçoğlu and Cengiz, 2020).

Variance analysis was applied to the data obtained through the JMP program according to the random blocks trial pattern, and the significant means were compared with the LSD test. Correlation analysis was performed to determine the relationship between the features examined with the same program (JMP 5.0.1, 2002).

**RESULTS and DISCUSSION**

Plant height, stem diameter, first cob height, leaf ratio, stem ratio, cob ratio, forage yield, and dry matter yield of silage maize
varieties are given in Table 1. It was observed that the difference between maize varieties was statistically significant in terms of plant height, first cob height, forage yield, leaf ratio, stem ratio, cob ratio, and dry matter yield. Only the difference between the cob diameters of maize varieties was not statistically significant (Table 1).

The highest plant height and the highest first cob height were obtained from Syngenta atomic and LG 30.597 varieties. The average plant height of the varieties was 232 cm, and the average height of the first cob was 71.0 cm. The stem diameters of maize varieties varied between 17.6-21.6 mm and the average were obtained as 19.7 mm (Table 1).

Plant height in previous studies; It was determined as 264.2 cm in Bingöl ecological conditions (Çaçan and İşikten, 2019), 192.7 cm in Kayseri ecological conditions (Bulut, 2016), 248.8-291.6 cm in Diyarbakır ecological conditions (Seydoçoğlu and Saruhan, 2017), and 323-392 cm in İzmir ecological conditions (Yıldız et al., 2017). The maize plant is a hot climate plant. The minimum germination requirement is 8-10 °C, and the optimum temperature requirement is above 18 °C (Geçit et al., 2011). Since maize plant is a hot climate plant, it is seen that plant height gives higher values in hot ecologies such as İzmir and Diyarbakır, and lower values in relatively cold regions such as Bingöl and Kayseri. Of course, features such as the plant's genetic structure, variety characteristics, cultivation methods, and soil structure are factors that affect the plant height. However, among all these features, it should be known that the most prominent feature for the maize plant is the climate.
Table 1. Plant height, stem diameter, first cob height, leaf ratio, stem ratio, cob ratio, forage yield, and dry matter yield of maize varieties

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Plant height (cm)</th>
<th>Stem diameter (mm)</th>
<th>First cob height (cm)</th>
<th>Leaf ratio (%)</th>
<th>Stem ratio (%)</th>
<th>Cob ratio (%)</th>
<th>Forage yield (kg/da)</th>
<th>Dry matter yield (kg/da)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Es Armandi</td>
<td>217&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>21.1</td>
<td>59.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>53.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4013&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1459&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>DKC 5741</td>
<td>227&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20.5</td>
<td>60.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>128&lt;sup&gt;b&lt;/sup&gt;</td>
<td>43.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>43.9&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4672&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1854&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Syngenta Atomik</td>
<td>249&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19.0</td>
<td>84.2&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>13.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>43.6&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>42.5&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>6095&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2146&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>LG 30.500</td>
<td>230&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.6</td>
<td>73.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>46.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4688&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1915&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>LG 31.545</td>
<td>211&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18.1</td>
<td>60.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>47.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4354&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1905&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>LG 30.597</td>
<td>257&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.6</td>
<td>88.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>51.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>36.0&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>7259&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2506&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mean</td>
<td>232</td>
<td>19.7</td>
<td>71.0</td>
<td>14.0</td>
<td>45.1</td>
<td>40.9</td>
<td>5180</td>
<td>1965</td>
</tr>
<tr>
<td>CV (%)</td>
<td>3.59</td>
<td>8.17</td>
<td>8.65</td>
<td>14.02</td>
<td>9.17</td>
<td>14.30</td>
<td>14.16</td>
<td>14.43</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>15.12</td>
<td>--</td>
<td>11.17</td>
<td>3.56</td>
<td>7.53</td>
<td>10.64</td>
<td>1334.16</td>
<td>515.67</td>
</tr>
</tbody>
</table>

High stem diameter values are not desirable in maize plants. Because when the stem diameter increases, the dry matter ratio increases during the silage stage, which causes the silage quality to decrease. However, there are advantages to a thick stem diameter. Thick stem diameter prevents the plant from lying down. In cases where the throat filling process is not done properly, the thin stalk causes the plant to lie down in areas with high wind force and especially in the stages where the plant fills the grain. The plant stem diameter values obtained in this study were similar to the 20.9 mm values obtained in Bingöl ecological conditions previously (Çaçan and İşikten, 2019) and 21.9
mm values obtained in Çankırı ecological conditions (Kuşvuran et al., 2015). It was found to be lower than the values obtained in hot regions. For example, stem diameter was determined to be between 20.1-28.4 mm (Seydoşoğlu and Saruhan, 2017) in Diyarbakır ecological conditions and between 21.3-28.3 mm in İzmir ecological conditions (Ayaz et al., 2013).

It is seen that the height of the first cob is directly proportional to the plant height. In varieties with high plant height (LG 30.597 and Syngenta atomic), it is seen that the first cob height is also high. Considering the previous studies, it is seen that the findings obtained from this study give lower values than the findings obtained from other studies (Olgun et al., 2012; Yıldız et al., 2017; Yozgatli et al., 2019). The probable reason for this difference is that LG 30.597 is a variety that is considered directly for silage, while other varieties are considered for grain purposes. However, in terms of being the species that preserve their greenness for a long time, their performance as silage has been tried to be tested. For this reason, it is seen that the first cob heights are low. As a matter of fact, the similarity of the varieties grown for grain purposes with the heights of the first cob (İdikut et al., 2015) supports this claim. From this point of view, it is understood that the height of the first cob is an important criterion to be taken into consideration when evaluating a variety as silage (after yield and plant height).

The highest leaf rate was obtained from Es armandi, the highest stem rate from Es armandi and LG 30.597, and the highest cob rate from DKC 5741, Syngenta atomic, LG 30.500 and LG 31.545. The average
The leaf ratio was determined as 14.0%, the average stem ratio was 45.1% and the average rate of the cob was 40.9% (Table 1).

Leaf, stem, and cob ratios of a maize plant are important parameters that enable us to obtain information about the silage performance of that plant. Es armandi, Syngenta atomic and LG.30.597 varieties have higher stem ratios than cob rate. This result gives an idea that the silage performance of these varieties is high. However, it is understood that Es armandi variety does not cause a difference in the total forage yield due to the low plant height. It is understood that the remaining varieties stand out in terms of grain yield. The obtained leaf, stem, and cob ratios were found to be similar to the values obtained from previous studies (Keskin et al., 2017; Kuşvuran et al., 2015; Özata et al., 2012).

The highest forage yield and dry matter yield were obtained from varieties named Syngenta atomic and LG.597. The average forage yield was 5180 kg da⁻¹ and the dry matter yield was determined 1965 kg da⁻¹.

It is seen that Syngenta atomic and LG 30.597 varieties, in which plant height, first stem height, and stem ratio were determined higher than the rate of cob, gave the highest values in terms of forage yield and dry matter yield. While the average forage yield of 5180 kg da⁻¹ and the dry matter yield of 1965 kg da⁻¹ were similar to the results obtained by Ayaz et al. (2013), it was determined that they were lower than the results (forage yield 7902 kg da⁻¹, dry matter yield 2351 kg da⁻¹) obtained from the study conducted under Bingöl conditions (Çaçan and İşikten, 2019). The absolute reason for this difference is that the
varieties used are different. Even if the region and climatic conditions are the same, it is seen that only the variety difference causes a difference of over 50% on forage yield.

**Correlation Between Examined Features**

The correlation analysis of the properties of the maize plant examined in the study is given in Table 2. It is seen that there is a significant and positive relationship between plant height and first cob height, forage yield, dry matter yield, between stem diameter and forage yield, between first cob height and forage yield, dry matter yield, between leaf ratio and stem ratio and between forage yield and dry matter yield. It is seen that there is a significant and negative relationship between leaf ratio, stem ratio, and dry matter yield, and between stem ratio and cob ratio (Table 2).

**Table 2.** Correlation between traits examined in maize varieties

<table>
<thead>
<tr>
<th></th>
<th>Stem diameter</th>
<th>First cob height</th>
<th>Leaf ratio</th>
<th>Stem ratio</th>
<th>Cob ratio</th>
<th>Forage yield</th>
<th>Dry matter yield</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant height</strong></td>
<td>0.30</td>
<td>0.89**</td>
<td>-0.21</td>
<td>0.21</td>
<td>-0.09</td>
<td>0.80**</td>
<td>0.66**</td>
</tr>
<tr>
<td><strong>Stem diameter</strong></td>
<td>0.09</td>
<td>0.18</td>
<td>0.39</td>
<td>-0.35</td>
<td>0.47*</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td><strong>First cob height</strong></td>
<td>0.34</td>
<td>0.05</td>
<td>0.07</td>
<td>0.73**</td>
<td>0.71**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Leaf ratio</strong></td>
<td>0.73**</td>
<td>-0.34</td>
<td>0.86**</td>
<td>-0.29</td>
<td>-0.64**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stem ratio</strong></td>
<td>0.98**</td>
<td>-0.04</td>
<td>0.18</td>
<td>-0.21</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cob ratio</strong></td>
<td>-0.04</td>
<td>0.80**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The correlation coefficients are evaluated using the Fisher z-transformation method, and significant correlations are indicated with *p < 0.05; **p < 0.01.*
CONCLUSION

Variety-adaptation studies should be carried out for at least two years in order to make a variety recommendation. However, it is a fact that one-year studies provide us with an idea about the performance of the varieties. Accordingly, when a general evaluation is made, it is seen that the highest plant height, first stem height, forage yield, and dry matter yield were obtained from LG 30.597 and Syngenta atomic varieties. Therefore, as a result of a one-year study, it was concluded that LG 30.597 and Syngenta atomic named varieties should be preferred when cultivation for silage purposes among these maize varieties.
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