INVESTIGATIONS ON FORAGE YIELD OF OAT GENOTYPES UNDER IRRI-GATED CONDITIONS OF KONYA

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Oat is an important cereal as human food and animal feed. This research was aimed to evaluate some oat genotypes (lines and cultivars) for forage yield and forage quality parameters. Research was carried out in Konya irrigated conditions, in Spring 2018 with 12 oat genotypes [nine lines (BDY-1, BDY-2, BDY-3, BDY-4, BDY-5, BDY-6, BDY-7, BDY-8, BDY-9) and three were registered cultivars (Dirilis, Cheocota, Seydisehir)]. The trial was established according to the Randomized Blocks Experimental Design with three replications. Oats genotypes were harvested at milk to dough period. The traits such as days to heading (68-85 days), green forage yield (23420-31090 kg ha^-1), dry forage yield (6140-9940 kg ha^-1), plant height, (80-109 cm.), the number of stems per square meter (453.33-677.33 pieces), the number of fertil stems per square meter (133.33-450.83 pieces), fertile cluster ratio (28.22-80.57%), the number of node per stems, (3.73-4.77 pieces), stem thickness (3.68-5.62 mm), 10 stem weight (68.52-133.46 g), leaves weight (13.02-35.06 g), leaf stem ratio (14-27 %), cluster (panicle) length (17.48-22.72 cm), flag leaf length (14.63-23.90 cm) and the number of leaves per stems (4.07-4.87 pieces) were investigated.

Keywords: Avena sativa L., cereal, genotypes, animal feed, green forage, Yield, Yield components.

INTRODUCTION

Oat (Avena sativa L.) is an important cereal plant grown as a cultivated plant and used in both human and animal nutrition. In recent years, the increasing importance of oats in human nutrition in the world and its use in industry has led to an increase in production area. Besides being animal feed and human food; It has gained importance especially in recent years due to the increase in usage areas in the pharmaceutical and cosmetic industry (Çeri and Acar, 2019a). Turkey has a potential in the world in terms of the number of animals. However, in terms of animal feed production and consumption, Turkey is insufficient compared to the developed world. The area of oat planted for green forage in Turkey was 82,551, 80,364, 82,628, 82,589, 86,790, 106,356 and 214,257 hectares in 2012, 2013, 2014, 2015, 2016, 2017 and 2018, respectively, whereas the green forage production in the same years was 934,157, 1,088,168, 1,156,553, 1,180,294, 1,549,846, 1,755,323 and 2,843,686 tons, respectively (Çeri and Acar, 2019b).

Quality roughage production plays a key role in the development of the forage crops and livestock industry. In addition, feed and feeding costs, which cover a large part of 60-70% during the production stage in the livestock industry, significantly affect the profitability of the enterprise. One of the quality roughage sources is forage plants (Özkan and Şahin Demirbağ, 2016). In order to increase animal production, inexpensive and easily available feed sources are required by the producers. Of these sources, oats are an important alternative herb. Oat is a priority product as animal food in the world, and it is inevitable to increase its production in our country, considering the importance of oats in animal nutrition (Sayar, 2017). In this research article the forage yield and some forage yield components of some oat varieties and lines in Konya irrigated conditions are investigated.

MATERIALS AND METHODS

The field study was conducted at the Bahri Dağdaş International Agricultural Research Institute (BDIARI) in Konya in irrigated conditions during the early spring growing season of 2018. The experimental design of this research was a randomized complete block design (RCBD) with factorial arrangement and three replications of the
selected 12 oat genotypes, which were nine lines and three cultivars (Table 1). BDY-1, BDY-2, BDY-3, BDY-4, BDY-5, BDY-6, BDY-7, BDY-8, BDY-9 lines were provided by Bahri Dagdas International Agricultural Research Institute (BDIARI). Diriliş, Cheocota, and Seydişehir varieties were also used as research materials. Seydişehir oat variety, which released in 2004 by BDIARI, is a local variety and has favorable forage yield. Cheocota oat variety, released by Eskisehir Transitional Zone Agricultural Research Institute (ETRI), is selected for its high quality traits.

Table 1. Oat genotypes used in the experiment.

| G.N.  | Pedigree                                                                 |
|-------|--------------------------------------------------------------------------|
| BDY1  | ND040492(ND970216/Souris)/FL0917F1(OA 1178-2/FL03184-K9)                |
| BDY2  | FL0105-H3 TX97C1168/IA91462-45-6                                         |
| BDY3  | BW 803/FL.99078-H1                                                       |
| BDY4  | UFRGS 046054-2/MN0612                                                  |
| BDY5  | UFRGS 028153-2(UFRGS 881971/PC68*5/STARTER F4)/FL0109 - H3             |
| BDY6  | UFRGS 046054-2/MN0612                                                  |
| BDY7  | FL0567-L1(UFRGS028152-1/FL0123-H2)/FL0905F1(UFRGS87212-1 /LA9891BI-42 F4) |
| BDY8  | NC03-2421 /LA90994, F1(UFRGS087212-1 /LA04004SB-61-B-S1)               |
| BDY9  | UFPF97HI300-2-12 /ND030349                                               |
| BDY10 | DIRILIS                                                                  |
| BDY11 | CHEOCOTA                                                                 |
| BDY12 | SEYDISEHIR                                                               |

During study period in 2018, the average temperature was higher than many previous years (Table 2). The drougt month of spring was April, with 14.4 mm of precipitation (Table 2). Table 2 also shows the relative humidity rate, which averaged 60.4% in the spring 2018. During the research period, rainfall, which usually falls in April, was spread over May and the following months due to climate change. Thus, the total amount of precipitation in the spring period (March-June 2018) was 161.4 mm, while it had been a total of 126.8 mm for previous years (Table 2).

Table 2. Average temperature and rainfall in Konya during 1950-2018 and Spring (March-June, 2018) cultivation period.

| Months  | Temperature (°C) | Rainfall (mm) | Relative humidity (%) |
|---------|------------------|---------------|-----------------------|
|         | 1950-2018        | 2018          | 1950-2018             | 2018 |
| March   | 5.5              | 9.8           | 26.2                  | 36.0 | 67.6 |
| April   | 11.1             | 13.9          | 38.8                  | 14.4 | 52.9 |

Soil samples of the experimental site were collected from topsoil (0-30 cm depth) and analyzed for defining the physical and chemical properties of the field. The soil analysis illustrated that the soil has a clay-loam structure with medium (1.83%) organic matter, high lime content (31.32%) and alkaline (pH: 8.30) reaction. The soil had a sufficient phosphorus (90 kg ha⁻¹), and potassium (755.3 kg ha⁻¹). Also, the soil analysis results highlight no salinity problem.

Oat seeds were sown on 450 plot/m² in irrigated conditions on the 27th of March in 2018. The Plot dimensions of the experiment were 8.4 m² (1.2 x 7 m) with six rows and 20 cm spaced apart from each row. The field experiment was irrigated at 3 stages: 1) during the plantation, 2) 2-5 tillering, 3) 2-3 cm stalk height (Zadoks growth scale 30-31). Irrigation was applied after fertilization for six hours. In the experiment, 9 kg da⁻¹ P₂O₅ and 12 kg da⁻¹ N fertilizer was applied. Weed was controlled by using a chemical (2.4-D Ester, 130 g da⁻¹).

The period between milk and pulp death was highly recommended for the shaping of oats and other cereal grains by Staples (1989). For this reason, trial plots were cut with a reaping-hook during the milk to dough stage. Correlation coefficients among forage growth, grain yield, and other traits were analyzed by the statistics program JMP 11.

Investigated Features

| Number of days of heading | The date when 50% of the plants in the plot were clustered (Fowler, 2009). |
|---------------------------|-------------------------------------------------------------------------|
| Green forage yield (kg/da) | Green forage yield was determined by the method of Albayrak (2003). Oat genotypes were harvested during the milk and dough death period. The oat forage harvested from 1 m² area was weighed and converted to ha and green forage yield was calculated. |
| Dry forage yield (kg/da)   | After weighing the green forage harvested from each plot, 0.5 kg of green forage samples taken randomly were placed on paper bags and dried in a drying cabinet at 70 °C for 48 hours (Ünal, 2011). The samples taken out of the drying cabinet were kept at room temperature for 24 hours and then weighed on an electronic scale with 0.05 g precision in order to determine the dry forage weight. Dry forage yields per hectare were calculated as kg ha⁻¹ from the values obtained. |
| Plant height (cm)          | In each plot, 10 plants were randomly selected before harvest for plant height. The plant height was measured in cm from soil level to the top of the main cluster by modifying the method described by Balabanli and Ekiz (1996). |
Number of stems per square meter: The method of Tosun and Yurtman (1973) was modified and used to determine the number of stems per square meter. Stems that in (1 m²/0.2m) 0.2 m² area in each row were counted in each and the number of stems per square meter was calculated by multiplying by 5.

The number of stems with clusters per square meter: The method of Sobayoğlu (2017) was modified and used to determine the number of clustered stems per square meter. Stems in 1 m area in each row were counted and multiplied by 5 in each plot, and the number of clustered stems per m² was worked out.

Cluster length (cm): In the cluster of 10 plants determined randomly in each plot, the length from the lower node of the cluster to the top of the cluster, excluding the awns, was measured in cm (Yağbasanlar, 1987).

The Fertile (with cluster) stem ratio (%): The number of stems with clusters per square meter x100

The number of nodes in the stem: In each plot, the number of internodes of the plants above the ground level were counted.

Stem thickness (mm): Randomly selected 10 plants before harvesting in each parcel were removed with roots and the thickness of the main stem between the 2nd and 3rd node was measured with a 0.1 mm compartment caliper and the value obtained was taken as the average main stem thickness (Sayar, 2011).

Leaf weight on the stem (g): The leaves on the main stem of 10 plants taken from each plot were counted and separated from the bottom of the leaf sheath and weighed in grams (Yürür et al., 1981).

Leaf stem ratio (%): 10 plants were randomly selected from each plot, leaves and stems were separated, weighed and determined (Bares et al., 1985).

Formula was used as

\[(10 \text{ Stems of leaves weight} / 10 \text{ Stems weight}) \times 100\]

Flag leaf length (cm): The method of Bares et al. (1985) was modified and used to determine the flag leaf length. 10 plants were selected from each parcel, the length of the flag leaf was measured in cm.

The number of leaves on the stem: The leaves on the main stem of 10 plants taken from each plot were counted and expressed as average leaf number (Yürür et al., 1981). The findings obtained as a result of the study were subjected to variance analysis with the help of the JMP (11) statistical package program in accordance with the Trial Pattern of Random Blocks with three repetitions. According to the results of variance analysis, statistically significant factor averages were compared with the LSD test (Kalayci, 2005).

RESULTS AND DISCUSSION

Number of days of Heading: The number of days of heading in oat genotypes ranged 68-85 days (Table 3). According to this, the earliest lines were BDY-1 and BDY-3 (68 days); Cheocota has been 70 days. The lines with delayed heading were BDY-5 (78 days) and BDY-6 (78 days); whereas the late variety was Seydişehir (85 days). In studies on a similar feature, Gül et al. (1999) reported 116.2-129.5 days to heading; whereas Yağbasanlar et al. (1990) determined 116-122 days. It was determined that the values we obtained are lower. This may have resulted due to different genotypes, environmental conditions, applied

| Genotypes   | HD (day) | GFY (kg ha⁻¹) | DFY (kg ha⁻¹) | PH (cm) | M² NS (No. m⁻²) | M² NFS (No. m⁻²) | FSR (%) |
|-------------|----------|----------------|----------------|---------|-----------------|-----------------|---------|
| BDY-1       | 68       | 27.46abc       | 7.07c-f        | 108.00a | 477.50c         | 385.00ab       | 80.57a  |
| BDY-2       | 73       | 24.19bc        | 6.14f          | 100.00d | 604.17ab        | 357.50ab       | 59.19bc |
| BDY-3       | 68       | 24.07bc        | 7.54bd         | 98.00bde | 586.67ab    | 450.83a        | 77.40a  |
| BDY-4       | 72       | 27.83abc       | 9.94a          | 100.00abc | 605.00ab   | 400.83ab       | 66.31ab |
| BDY-5       | 78       | 23.77bc        | 6.94def        | 91.00de  | 453.33c        | 133.33f        | 29.77e  |
| BDY-6       | 78       | 24.21bc        | 6.83def        | 91.00cde | 468.33c       | 286.67cde      | 60.90bc |
| BDY-7       | 76       | 31.09a         | 8.46bc         | 109.00a  | 475.00c        | 287.50cde       | 59.79bc |
| BDY-8       | 74       | 29.00ab        | 8.81ab         | 95.00bde | 541.67bc    | 217.50def       | 40.22de |
| BDY-9       | 70       | 24.38bc        | 7.88bd         | 102.00ab | 509.17bc    | 277.50cde       | 54.81bcd |
| Diriliçta  | 72       | 23.42c         | 8.10bd         | 80.00f   | 465.83c        | 307.50bcd       | 65.59abc |
| Cheocota    | 70       | 28.46abc       | 8.87ab         | 108.00a  | 537.50bc       | 270.83cde       | 50.46cd |
| Seydişehir | 85       | 30.25a         | 6.27ef         | 90.00e   | 677.33a        | 190.83ef        | 28.22e   |
| Average     | 74       | 26.51          | 774.00         | 97.60    | 533.46         | 296.74          | 56.10   |
| CV (%)      | 12.00    | 11.00          | 5.82           | 10.70    | 19.50          | 15.96           |         |
| LSD(0.05)   | 5.44     | 1.39           | 9.63           | 22.92    | 98.02          | 15.16           |         |

(*): P < 0.05 ; (**): P < 0.01 ; HD: days to heading; GFY: green forage yield; DFY: dry forage yield; PH: plant height; M² NS: the number of stems per square meter; M² NFS: the number of fertil stems per square meter; FCR: fertile stem ratio
cultural processes or planting time.

**Green forage yield (kg ha⁻¹):** The green forage yield of the oat genotypes used in the study was statistically significant at the level of 5% (p<0.05). The green forage yield of the oat genotypes used in the study varied between 23.420-31.090 kg ha⁻¹, the average green forage yield was 26.510 kg ha⁻¹ (Table 3). There were statistically different groups in the oat genotypes used in the study in terms of green forage yield. Accordingly, the first group from the lines BDY-7 (31.090 kg ha⁻¹), while Seydişehir (30.250 kg ha⁻¹), one of the varieties in the same group, was formed and the last group was Diriliş (23.420 kg ha⁻¹) regarding green fodder yield.

The green grass yield of 26.510 kg ha⁻¹ was produced by Acar and Özmaynak (2000) obtained 1.491.8 kg ha⁻¹ and Nawaz et al. (2004) 14.160 kg ha⁻¹ green fodder yield. On the other hand, the average value of 26.510 kg ha⁻¹ in this study varied by Lithourgidis et al. (2006) average yield (3.323 kg ha⁻¹) and Avci (2017) winter crop (55.650 kg ha⁻¹) and and summer crop (37.390 kg ha⁻¹); whereas Kara (2017) recorded 34.886 kg ha⁻¹ green fodder yield.

**Dry forage yield (kg ha⁻¹):** The dry forage yields of the oat genotypes were statistically significant at the level of 1% (p<0.01). The hay yield of the oat genotypes varied between 6.140-9.940 kg ha⁻¹, the average dry forage yield was 7.740 kg ha⁻¹ (Table 3). Accordingly, BDY-4 (9.940 kg ha⁻¹) from genotypes formed the first group (a) alone. In the genotypes, the last group (f) formed BDY-2 (6.140 kg ha⁻¹).

Acar and Özmaynak (2000) recorded hay yield 1.223.1 kg ha⁻¹ from oats; while Kara (2017) Caballero et al. (1995), Carr et al. (2004) and Nawaz et al. (2004) obtained the dry matter yield of oats (5.761.4 kg ha⁻¹, 6.570 kg ha⁻¹, 2.910 kg ha⁻¹ and 1.900 kg ha⁻¹, respectively).et al. et al Avci (2017) determined an average dry forage yield of 6.884 kg ha⁻¹ from summer cultivation. According to our results, the hay yields obtained were higher than the results of these researchers. On the other hand, the hay yield of 7.740 kg ha⁻¹ found by Lithourgidis et al. (2006) was (11.620 kg ha⁻¹) and Avci (2017) was high obtained in winter planting (12.629.3 kg ha⁻¹).

The difference in hay yield may be because of genotypes, environmental conditions, applied cultural practices and planting times.

**Plant height (cm):** The difference between varieties in terms of plant height of oat genotypes was found statistically significant (p<0.01) and grouped separately (Table 3).

Accordingly, the first group was comprised of lines BDY-1 (108 cm) and BD-7 (108.7 cm), while Cheocota (107.9 cm) entered the same group, and the last group was Diriliş (79.6 cm.). The lines and varieties studied in the experiment were listed between these two groups. Nawaz et al. (2004) also reported that the plant height was significantly different in all varieties. While the plant height of the oat genotypes used in our study varied 79.6 cm-108.7 cm and average plant height was 97.6 cm, which was higher than reports. Acar (1995) in his studies determined the average plant height as 67.11 cm. Avci (2017) determined the plant height in oat genotypes as 54.09 cm in summer planting. Similarly Gul et al. (1999) and Erbas (2012) recorded plant height in oat genotypes as 79.98-103.60 cm and 66.0-109.2 cm. In terms of plant height in the oat genotypes, Avci (2017) determined average values of 139.52 cm in winter cultivation and 108.78 cm by Kara (2017), which is higher than 97.6 cm that we found in our study. The differential results may be because of different genotypes, environmental conditions, applied cultural processes or planting time.

**Number of stems per square meter:** The difference between the varieties in terms of stem number per square meter was found to be statistically significant (p<0.01). The lines BDY-2 (604.17 stem/m²), BDY-3 (586.67 stem/m²) and BDY-4 (605 stem/m²) were included in the same group. Only Seydişehir variety produced significantly higher stems (677.33 stem/m²). Among the varieties, the lowest value (465.83 stem/m²) was recorded in Diriliş. The average number of stems of oat genotypes was 533.46 per square meter and ranged 453.33-677.33 stem/m² (Table 3).

Narlıoğlu (2016) observed the low number of 362 stems per square meter than recorded in this research (533.46 stem/m²).

Sobayoğlu (2017) studied a range of 430-532.5 stem/m² with average 475 stem/m². Hisir (2009) counted 502.00 - 665.25 stem/m² which were similar to our research studies. Peltonen-Sainio and Järvinen (1995) stated that the number of stems per square meter should be evaluated together with other characteristics, not alone. The variation in values can be dependent on different genotypes, environmental conditions, applied cultural processes and planting time.

**Cluster (Panicle) length (cm):** The difference between the genotypes in terms of cluster length was found to be statistically significant (p<0.01). The lines BDY-7 (22.70 cm) and Cheocota (22.72 cm) grouped with the highest value, while the cultivars Diriliş had the lowest cluster length (17.48 cm). The other studied lines and varieties listed between these two groups (Table 3).

Erbas (2012) determined the cluster length as 14.7-25.8 cm, Özgen (1993) as 23.3 cm and Nirmalakumari et al. (2013) as 15.01-33.23 cm. The values obtained by these researchers are closer and compatible with the values we obtained in our research. However, the average cluster length of oat genotypes was 30.60 cm (Hisir, 2009) and 22.80 cm (Yellow, 2012). These values were higher than the 19.67 cm value, we determined in our studies. The difference in panicle length observed may be because of genotypes, environmental conditions, applied cultural practices and planting times.

**Number of fertile (cluster) stems (m⁻²):** The difference between genotypes in terms of the number of fertile stalks per square meter was found statistically significant (p<0.01). In our research, the lines BDY-3 line with (450 stem/m²) and BDY-(4400.83 stem/m²) and BDY-1 (385 stem/m²) were statistically non-significant with each other.
and yielded the highest number of fertile stems (Table 3). The line BDY-5 had the lowest number of fertile stems (133.33 stem/m²).

Among the varieties in our study, Diriliş got the highest value with 307.50 stem/m², while the lowest value was found in Seydişehir variety with 190.83 stem/m². Overall, the number of fertile stalks varied as 133.33-450.83 stem/m²; while the average number of fertile stalks was 296.74 stem/m².

Naneli and Sakin (2017) found that the average number of fertile clusters per square meter was between 567.6 and 646.8 in their study. However, Maral (2009) determined that the average number of clusters per square meter of varieties ranged 334-506 stem/m². It was found that the values we recorded were lower than the values of other researchers. The difference in number of fertile stems observed may be because of genotypes, environmental conditions, applied cultural practices and planting times.

*Fertile (with cluster) stem rate (%):* The difference between genotypes in terms of fertile stem ratio was found to be statistically significant (p <0.01). In our study, the fertile stem ratio ranged 28.22-80.57%; while the average fertile stem rate was 56.10%. Among the lines, BDY-1 and BDY-3 had the highest fertile stem rates (80.57 and 77.40%, respectively) followed by BDY-4 (66.31%).

Öztürk (1999) determined the fertile stem rate of 75.7% in his study in wheat under irrigated conditions. Although this value is close to our study but the average value was higher than 56.10%. The difference in fertile stem rate observed may be because of genotypes, environmental conditions, applied cultural practices and planting times.

*The number of nodes in the stems:* The variation among genotypes in terms of the number of nodes in the stem was statistically significant at the level of 1%. In our study, the number of nodes in the stem varied between 3.73 and 4.77 with an average number 4.15 (Table 4). The highest node number was recorded in lines BDY-7 (4.5) and BDY-6 (4.33). It was determined that BDY-3 line received the lowest number of nodes (3.73). Among the varieties, the highest number of nodes was found in Cheocota (4.77).

Erbaş (2012) reported 2.0-4.8 number of nodes in the main stem. Çalışkan and Koç (2019), in their study on local varieties, have observed 14 genotypes with 5-6 nodes, 61 genotypes with 6-7 nodes, 46 genotypes with 7-8 nodes, 40 genotypes with 8-9 nodes on the main stem. They further reported that they identified 3 genotypes with more than 9 nodes on main stem of the standard varieties with a range 4-8.1 and average 5.8.

The values obtained by Erbaş (2012) and our’s coincided; however, the values obtained by Çalışkan and Koç (2019) were higher than the values we obtained in our study. These variations may be due to environmental conditions, applied cultural processes and planting time.

*Stem thickness (mm):* The variation among genotypes in terms of stem thickness was statistically significant (p <0.01). In the oat genotypes used in the study, statistically different groups were formed in terms of stem thickness (Table 4). The maximum stem thickness was recorded in lines BDY-5 (5.62 mm) and BDY-7 (5.33 mm). The line BDY-3 yielded the minimum stem thickness (3.68 mm). In the oat genotypes used in the study, stem thickness varied 3.68-5.62 mm, while the average stem thickness was 4.48 mm.

Erbaş (2012) determined the stem thicknesses in the range of

| Genotypes   | SNN (No.) | ST (mm) | 10SLW (g) | 10SLW (g) | LW SW1 (%) | CL (cm) | FLL (cm) | S NL (No.) |
|-------------|-----------|---------|-----------|-----------|------------|---------|---------|------------|
| BDY-1       | 3.83fg    | 4.31cde | 95.70cd   | 13.02d    | 14.00g     | 20.65b  | 17.55de  | 4.17de     |
| BDY-2       | 4.00ef    | 3.89de  | 84.40de   | 21.86bc   | 26.00ab    | 18.10d  | 17.72cd  | 4.47bcd    |
| BDY-3       | 3.73g     | 3.68e   | 68.52e    | 13.36d    | 20.00ef    | 18.40d  | 17.43de  | 4.07e      |
| BDY-4       | 4.2cde    | 4.26cde | 77.63de   | 19.88bc   | 26.00ab    | 19.33bcd| 19.27bcd | 4.43bcd    |
| BDY-5       | 4.00ef    | 5.62ab  | 124.15ab  | 30.56a    | 25.00bc    | 19.37bcd| 22.68ab  | 4.23de     |
| BDY-6       | 4.33bc    | 4.54bcd | 79.32de   | 19.08c    | 24.00bc    | 19.43bcd| 19.73bcd | 4.43bcd    |
| BDY-7       | 4.50b     | 5.33ab  | 133.46a   | 35.06a    | 26.00ab    | 22.70a  | 23.90a   | 4.7abc     |
| BDY-8       | 4.27bcd   | 5.10abc | 107.55bc  | 24.56b    | 23.00cd    | 18.80cd | 19.22bcd | 4.63abc    |
| BDY-9       | 4.20cde   | 4.21de  | 89.31cd   | 21.50bc   | 24.00bc    | 18.63cd | 16.45de  | 4.77ab     |
| Diriliş     | 3.93fg    | 4.35cde | 78.44de   | 13.74d    | 18.00f     | 17.48e  | 14.63e   | 4.37cd     |
| Cheocota    | 4.77a     | 4.55bcd | 108.49bc  | 22.32bc   | 21.00de    | 22.72a  | 21.47abc | 4.87a      |
| Seydişehir  | 4.07def   | 3.94de  | 84.45de   | 23.23bc   | 27.00a     | 20.28bc | 16.38de  | 4.73b      |
| Average     | 4.15      | 4.48    | 94.28     | 21.51     | 23.00      | 19.67   | 18.87    | 4.49       |
| CV (%)      | 3.80      | 11.26   | 12.00     | 13.20     | 6.77       | 5.03    | 12.08    | 4.62       |
| LSD(0.05)   | 0.27      | 0.85    | 19.53     | 4.81      | 0.03       | 1.67    | 3.86     | 0.35       |

(*) P < 0.05; (**) P < 0.01; SNN: the number of node per stems; ST: stem thickness; 10SW: 10 stem weight; 10SLW/SW: leaf stem ratio; CL: cluster (panical) length; FLL: flag leaf length; S NL: the number of leaves per stems
Oat genotypes for forage

2.11-4.89 mm. Our result was consistent with the data of this study. Similarly, our results coincided with a range of 4.3-6.1 mm, which Narlıoğlu (2016) studied in 16 oat genotypes. Ahmad et al. (2008) stated that the stem thickness of oat is important with reference to lodging and forage yield.

**10 Stem weight (g):** The oat genotypes were statistically significant at the level of 1% in terms of ten stem weight (Table 4). The line BDY-7 yielded the maximum (133.46 g) 10 stem weight, while the lowest (68.527 g) was recorded in line BDY-3. While ten stem weights in the oat genotypes used in the study ranged 68.52-133.46 g with an average of 94.28 g. Çeri et al. (2018) reported the highest single stem weight 6.06 g (60.6 g for ten stems) and the lowest single stem weight 5.25 g (52.5 g for ten stems) in their study on 31 oat lines in 2015. Values of ten stems in our study were 68.52-133.46 g. The difference in stem weight observed may be because of genotypes, environmental conditions, applied cultural practices and planting times.

**Leaf weight in 10 stem (g):** The leaf weight in ten stems of genotypes was statistically significant (p <0.01) in terms of leaf weight in ten stems (Table 4). The maximum leaf weight per 10 stem was documented in lines BDY-7 (35.06 g) and BDY-5 (30.56 g). The minimum leaf weight per 10 stem was recorded in the lines Diriş (13.74 g) and BDY-1 (13.02 g). In the used in the study, The leaf weights in ten stems of oat genotypes ranged from 13.02 to 35.06 g with an average of 21.51 g.

**Leaf weight/stem weight ratio (%):** The genotypes were statistically significant (p <0.01) in terms of leaf/stem ratio (Table 4). The first group (was composed of only Seydişehir with the highest leaf/stem ratio. The line BDY-1 produced the lowest (14%) leaf/stem ratio. The overall leaf/stem ratio of the oat genotypes ranged (14-27 %) with an average of 23%.

Choudhary (2016) carried out different fertilizer and irrigation practices in 2 forage oat varieties in their study during 2011-12 growing period and found the leaf/stem ratio of (51-55 %). The difference in leaf/stem ratio observed may be because of genotypes, environmental conditions, applied cultural practices and planting times.

**Flag leaf length (cm):** The genotypes used in the study were found to be statistically significant (p <0.01) in terms of flag leaf length (Table 4). The genotype BDY-7 attained the maximum (23.90 cm) flag leaf length. The lowest (14.63 cm) flag leaf length was noticed in genotype Diriş. The flag leaf length ranged 14.63-23.90 cm in oat genotypes with an average of 18.87 cm. Narlıoğlu (2016) found the flag leaf length 18.5-25.3 cm, which was consistent with our results. Çalskan and Koç (2019) reported that the flag leaf length varied between 18.4 and 45.8 cm and their average was 28.5 cm in local varieties, and these values were higher than the average we obtained in our study. Some researchers reported that the length of the flag leaves is dependent on cultivars (Semchenko and Zobel, 2005) and the environmental conditions (Gautam et al., 2006; Dumlupınar et al., 2012). The difference in flag leaf length observed may be because of genotypes, environmental conditions, applied cultural practices and planting times.

**The number of leaves on the stem:** The genotypes were statistically significant (p <0.01) in terms of the number of leaves on the stem (Table 4). Cheocota variety produced the maximum (4.87) number of leaves on stem among the genotypes. The genotype BDY-3 was the poorest (4.07) in terms of number of leaves on stem. Overall, the number of leaves on the stem varied 4.07-4.87 with an average of 4.49. Molla et al. (2018) studies on two stated tharange of number of leaves as CI-8251 (4.38) and CI-8237 (5.03). Alemu et al. (2007) reported the highest and lowest values of the number of leaves on the stem as 5.15 and 4.58, respectively. It was observed that the number of leaves in our study was compatible with the values obtained from other studies.

**Conclusion:** This study was carried out to determine the oat genotypes suitable for forage to meet the early spring feed deficit and reduce the pressure on pastures. The lines BDY-7 and BDY-8 were proved promising as forage-purpose oats. Among the varieties, Seydişehir oat variety stood outlier in terms of forage yield. It is necessary to increase the yield of fodder crops to overcome quality roughage deficit, and it is one of the ways that annual forage crops should be cultivated as the second crop for the production of roughage in irrigated areas.

**Author contribution statement:** Çeri S: Conceived the idea, designed the study, supervised research project and wrote the article; Çeri S: Research study and performed data analysis; Çeri S and Acar R: Field data collection and layout of experiment, reviewing and editing.

**Funding:** The financial support (project number 18201051) of BAP coordination, Selcuk University Institute of Science and Technology.

**Conflicts of interest:** No conflict of interest

**Acknowledgement:** This study is the part of Master's Thesis entitled “Investigation of grass yield, yield components and some weed quality properties of some oat varieties and lines in Konya irrigated conditions”. The authors acknowledge the financial support (project number 18201051) of BAP coordinationship, Selcuk University Institute of Science and Technology and experimental facilities of Bahri Dagdas International Agricultural Research Institute.

REFERENCES

Acar, R. 1995. Sulu şartlarda, ikinci ürün olarak bazı baklagil yembitkileri ve tahl karışımlarının yetiştirilme
Effects of Vicia villosa – Avena sativa – Amler, J. Maly and V. Berenek. 1985. Descriptors list of Triticum genus, 111.

Bares, I., J. Sehnolova, M. Vlasak, M. Vlach, Z. Krystof, P. Amler, J. Maly and V. Berenek. 1995. Descriptors list of Triticum genus, Prague, Czech Republic, p.78.

Ceri, S., T. Yıldırım, E. Yakışır, E. Özer, M. Türköz, İ. Kara, Ş.İ. Cerit and M. Yaşar. 2018. 2013-2017 Ulkesel Yulaf Islah Araştırmaları Sonuç Raporu, Bahri Dağdaş UTAEM, Proje No: TAGEM/TA/08/07/08/001 Yayın No: 2018-96.

Ceri, S. and R. Acar. 2019a. Serin iklim Tahillarının Hayvan Beslemesinde Yı剌 şil ve Kuru Ot Olarak Kullanılması. Bahri Dağdaş Bitkisel Araştırma Dergisi 8:178-194.

Ceri, S. and R. Acar. 2019b. Konya’da Sulu Şartlarda Hızlı Pekmez Üretiminin Verim ve Kalite Etkileri. Bahri Dağdaş Bitkisel Araştırma Dergisi 8:26-33.

Dumulpinaz, Z., R. Kara, T. Dokuyucu and A. Akkaya. 2012. Correlation and path analysis of grain yield and yield components of some Turkish oat genotypes. Pak. J. Bot. 44:321-325.

Erbaş, O. 2012. Yulaf (Avena sativa L.) Genotiplerinin Tarımsal ve bazı Kalite Özelliklerinin Belirlenmesi. Bozköm Üniversitesi, Yüksek Lisans Tezi, 100.

Fowler, D.B., 2009. Winter Wheat Production Manual: Growth stages of wheat, chap. 10. pp.1-15.

Gautam, S., A. Verma and S. Vishwakarma. 2006. Genetic variability and association of morpho-physiological characters in oat (Avena sativa L.). Farm Sci. J. 15:82-83.

Gul, I., C. Akinci and M. Çölkesen. 1999. Diyarbakır koşullarında uygun tane ve ot amaçlı yetiştirilecek yulaf çeşitlerinin belirlenmesi, pp.117-125.

Hisir, Y. 2009. Türkiye Yulaf Genotiplerinin Fizyolojik, Morfolojik ve Tarımsal Özellikler Yönünden. Kahramanmarash Sütçü İmam Üniversitesi, Doktora Tezi, pp.1-111.

Kalayci, M. 2005. Örneklerle Jump kullanımı ve tarımsal araştırma için vayrani analiz modelleri, Anadolu Tarımsal Araştırma Enst. Müd. Yayınları. Yayın No: pp.1-21.

Kara, E. 2017. Aydın koşullarında kişilik ara ürün olarak yetiştirilecek tek yıllık bazı baklagil ve buğdaygil yem bitkilerinin verim ve kalite özelliklerinin belirlenmesi, Yüksek Lisans Tezi, Adnan Menderes Üniversitesi, Fen Bilimleri Enstitüsü.

Lithourgidis, A., I. Vasilakoglou, K. Dhima, C. Dordas and C. Dordas. 2006. Forage yield and quality of common vetch mixtures with oat and triticale in two seeding ratios. Field Crops Res. 99:106-113.

Maral, H. 2009. Yulaf Çeşitlerinin Azotlu Gübreleme Yane Verimi, Azot Kullanımı ve Verim Özellikleri Yönünden Tepkisi. Kahramanmaras Sütçü İmam Üniversitesi, Yüksek Lisans Tezi, pp.1-61.

Molla, E.A., B.A. Wondimagegn and Y.M. Chekol. 2018. Evaluation of biomass yield and nutritional quality of oats–vetch mixtures at different harvesting stage under residual moisture in Fogera District, Ethiopia. Agriculture & Food Security, 7 (BioMed Central).
Naneli, İ. And M.A. Sakin. 2017. Bazı Yulaf Çeşitlerinin (Avena sativa L.) Farklı Lokasyonlarda Verim ve Kalite Parametrelerinin Belirlenmesi. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi 26:37-44.

Narlioglu, A. 2016. Bazı Yulaf Genotiplerinin Verim ve Kalite Kriterleri ile Silaj Özellikleri Bakımdan Değerlendirilmesi, Yüksek Lisans Tezi, K.S.Ü., Kahramanmaraş, p.72.

Nawaz, N., A. Razzaq, Z. Ali, G. Sarwar and M. Yousaf. 2004. Performance of different oat (Avena sativa L.) varieties under the agro-climatic conditions of Bahawalpur-Pakistan. Int. J. Agric. Biol. 6:624-626.

Nirmalakumari, A., R. Sellammal, G. Thamotharan, T. Ezhılarası and R. Ravikesavan. 2013. Trait association and path analysis for grain yieldin oat in the western zone of Tamil Nadu. International J. Agric. Sci. Res. 3:331-338.

Ozgen, M. 1993. Environmental adaptation and stability relationship between grain yield and some agronomic traits in winter oat. J. Agron. Crop Sci. 170:128-135.

Ozkan, U. and N.S. Demirbağ. 2016. Türkiye'de kaliteli kaba yem kaynaklarının mevcut durumu. Türkiye Bilimsel Derlemeler Dergisi 9:23-27.

Ozturk, A. 1999. Kuraklığın kışlık buğdayın gelişimi ve verimine etkisi. Türk Tarım ve Ormancılık Dergisi 23:531-540.

Peltonen-Sainio, P. and P. Järvinen. 1995. Seeding rate effects on tillering, grain yield, and yield components of oat at high latitude. Field Crops Res. 40:49-56.

Sari, N. 2012. Yulafta (Avena Sativa L.) Verim Ve Verim Komponentleri Arasındaki İlişkiler. Adnan Menderes Üniversitesi Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı.

Sayar, M.S. 2011. Diyarbakır Ekolojik Koşullarında Bazı Macar Fiği (Vicia pannonica Crantz.) Çeşit ve Hatlarının Önemli Tarımsal Özellikleri Yönden Değişik X Çevre Interaksiyonları ve Stabilitelerinin Belirlenmesi Üzerine Araştırmalar, Çukurova Üniversitesi Fen Bilimleri Enstitüsü Doktora Tezi.

Sayar, M. 2017. Ülkemiz ve bölgemizdeki yem bitkisi tarımına genel bir bakış, Diyarbakır'da Tarım, Ocak-Nisan, pp.30-34.

Semchenko, M. and K. Zobel. 2005. The effect of breeding on allometry and phenotypic plasticity in four varieties of oat (Avena sativa L.). Field Crops Res. 93:151-168.

Sobayoğlu, R. and A. Topal. 2016. Karaman Şartlarında Yazlık Ekilen Bazı Yulaf Genotiplerinin (Avena sativa L.) Verim ve Bazı Verim Unsurları Yönden Değerlendirilmesi. Bahri Dağdaş Bitkisel Araştırma Dergisi 5:28-34.

Staples, C.R. 1989. Small Grain Crops for Silage, Institute of Food and Agricultural Sciences (Document DS 26 of the Dairy Science Department, University of Florida, USA).

Tosun, O. and N. Yurtman. 1973. Ekmeklik buğdaylarda (Triticum aestivum L.) verime etkili morfolojik ve fizyolojik karakterler arasındaki ilişkiler, Ankara Univ. Ziraat Fak. Yilliği 30:485-502.

Unal, S., Z. Mutlu and H.K. Fırıncıoğlu. 2011. Performances of some winter Hungarian vetch accessions (Vicia pannonica Crantz.) on the highlands of Turkey. Turk. J. Field Crops 16:1-8.

Yagbasanlar, T. 1987. Çukurova’nın Taban ve Kıraç Koşullarında Farklı Ekim Tarihlerinde Yetiştirilen Değişik kökenli Yedi Triticale Çeşidinin Başlıca Tarımsal ve Kalite Özellikleri Üzerinde Araştırmalar. Doktora Tezi, Ç.Ü. Fen Bilimleri Enstitüsü, S-171, Adana.

Yagbasanlar, T., M. Çökkesen and Y. Kirtok. 1990. Çukurova Koşullarında Bazı Yulaf Çeşitlerinin Başlıca Tarımsal Özellikleri Üzerinde Bir Araştırma, ÇÜ Zir. Fak. Dergisi 6:95-110.

Yurur, N., O. Tosun, D. Eser and H. Geçit. 1981. Buğdayda Ana Sap Verimi ile Bazı Karakterler Arasındaki İlişkiler, Bilimsel Araştırma ve İncelemeler. AÜ Zir. Fak.Yayınları, 755-443.