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RESEARCH ARTICLE

DETERMINATION OF FORAGE PERFORMANCE OF SOME MEADOW BROMEGRASS (*BROMUS RIPARIUS* L.) CLONES IN THRACE REGION OF TURKEY.

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Abstract

The objective of this study was to determine the forage yield potentials of some meadow brome grass (*Bromus riparius* L.) clones in Trakya Region of Turkey. Thirty-one meadow brome grass clones were used as plant material in the study. The experiment was carried out in randomized complete block design with three replications at the experimental area of Field Crops Department of Agricultural Faculty of Tekirdag Namik Kemal University in 2012-2014. The fresh and hay yields of 31 meadow brome grass clones selected from a spaced plant nursery were determined in the study. The experiment was carried out two years as the clones were cut two times per year in a growing period.

Based on the results of the study, total fresh yield of meadow brome grass clones varied from 669.00 to 2561.33 kg/da and from 1563.00 to 5610.67 kg/da in the 1st and 2nd years, respectively, and total hay yield varied from 247.00 to 1625.33 kg/da and 540.00 – 1926.67 kg/da in 1st and 2nd years, respectively. Differences among fresh and hay yields of the clones were found to be statistically very significant ($P \leq 0.01$). The clones 314514-II, 315388, 315393, 315393-II, 440207, 536012-I, 536012-III, 536013-I, 536013-II and 536013-III had the highest mean fresh and dry yields, and these clones can be used as parents in policrosses to develop synthetic cultivars for the region.

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Introduction:-

Meadow brome grass, *Bromus riparius* Rehm. (also called *B. erectus* Huds. and *Bromus biebersteinii* (Roem. & Schult.) Holub) is a reduced creeping type of brome grass with good ability for regrowth (Knowles et al., 1993). It is native to southeastern Europe, the Caucasus, Turkey, and central Asia (Knowles et al., 1993). It has $2n = 70$ chromosomes (Tuna, et al., 2001) and is a cross pollinated species (Knowles et al., 1993). Meadow brome grass can grow on plains, mountain valleys, mountain brush, aspen, conifer forest and subalpine sites. It is adapted to a broad range of soil conditions but it performs best on moderately deep to deep, fertile, well-drained soils (Knowles et al., 1993). Meadow brome grass is moderate for salt tolerance (Sedivec et al., 2010). It can be grown under dryland conditions receiving greater than 355 mm of annual precipitation (St. John et al., 2012). Smeal et al. (2005) reported that forage production of meadow brome grass was greater than that of orchardgrass at less than 380 mm irrigation level, but was about equal at irrigation levels ranging from 380 to 810 mm. Meadow brome grass provides the greatest forage production and persistency in regions that have about 750 mm or higher precipitation per year. It has

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a moderate level of drought tolerance; however, at drier or less fertile sites, dry matter yield of meadow brome grass mixtures was higher compared to smooth brome grass mixtures when weather conditions for regrowth were favourable (Pearen et al., 1995).

In USA and Canada, meadow brome grass is used extensively for pasture and hay. It is well accepted by livestock due to its nutritious and palatable forage. Meadow brome grass has a growth pattern that suits it to short duration, high-intensity grazing. Plants of meadow brome grass have many basal leaves which, together with rapid recovery after grazing, make the grass useful for pasture (Knowles et al., 1993). Meadow brome grass has gained interest as a highly productive pasture grass that can be used under management of intensive grazing with limited irrigation. (Jensen et al., 2006). It also provides good erosion control with its dense network of fibrous roots (St. John et al., 2012). Meadow brome grass, which provides early growing, is often combined with legumes such as alfalfa (*Medicago sativa* L.). It also mixes well with grasses such as tall fescue (*Lolium arundinaceum* (Schreb.) Darbyshand) and orchardgrass (*Dactylis glomerata* L.) (Robins and Jensen, 2017; Bork et al., 2017).

In a study carried out in Canada by Knowles et al., (1993), meadow brome grass was compared with five other grasses including smooth brome grass and it was found that meadow brome grass yielded approximately 20% more forage than the averages of crested wheatgrass, smooth brome grass, orchardgrass, and meadow foxtail. Total dry matter yield (DMY) of meadow brome grass in half-sib families ranged from 0.52 to 9.88 Mg ha⁻¹ with a mean of 2.44 Mg ha⁻¹. Total DMY in parents ranged from 0.12 to 6.48 Mg ha⁻¹ with a mean of 1.30 Mg ha⁻¹ (Jensen et al., 2006). May et al. (1998) reported that DMY of meadow brome grass was 6.35 t ha⁻¹ in the 1st year, 7.02 t ha⁻¹ in the 2nd year, and 5.76 t ha⁻¹ in the 3rd year. The researchers determined crude protein ratio, ADF, NDF, lignin and ash of meadow brome grass as 11.8 - 9.7 %, 40.1 - 37.5 %, 6.53 - 6.68 %, 4.3 - 4.7 %, 7.3 - 6.0 % in both year, respectively.

The objective of this study was to determine the performance of meadow brome grass clones as forage crops in Tekirdag-Turkey conditions.

Materials and Method:-

Meadow brome grass clone experiment was established on 04 May 2012 by cloning of 31 single plants selected from a space planted nursery according to their performance.

The experiment was conducted during 2012-2014 at the experimental area of Field Crops Department of Tekirdag Namik Kemal University, Turkey. The experimental area was located at 36° 15' N and 36° 30' E direction and has generally a typical Mediterranean climate. The meteorological data of the experimental area is given in Table 1. It has a long-term rainfall of 585.0 mm. The total precipitation was 471.7 mm and 815.2 mm during the 2013 year and 2014 year, respectively. Average temperature of 2013 (15.4 °C) and 2014 (15.5 °C) years was higher than the long-term average value (14.1 °C).

Some important soil characteristics of the experimental area were determined before seeding. Based on the results of soil analysis, the soil had a clay-loam texture and moderate lime. Soil test values indicated a pH of 7.02 and 0.4 % CaCO₃, 107.0 kg ha⁻¹ phosphorus, 853.0 kg ha⁻¹ potassium and 1.53 % organic matter at the depth of 30 cm.

Table 1:- Climatic data of the mean temperature (°C) and total precipitation (mm) in 2012, 2013 and 2014 years and long-term average (1960 -2014) at Tekirdag, Turkey.

Months	Mean temperature (°C)				Total precipitation (mm)			
	2012 year	2013 year	2014 year	Long term	2012 year	2013 year	2014 year	Long term
January	-	6.5	8.0	4.9	-	97.1	44.4	69.1
February	-	7.8	8.7	5.4	-	102.6	6.0	54.4
March	-	9.6	9.9	7.3	-	55.8	73.6	55.2
April	-	13.5	13.4	11.9	-	17.9	46.8	40.9
May	18.1	19.5	17.5	16.8	60.2	9.6	72.1	38.7
June	24.1	22.4	21.8	21.3	0.0	37.9	69.6	37.0
July	27.0	24.7	24.8	23.8	5.5	0.3	72.1	23.1
August	26.0	25.9	25.3	23.7	7.8	0.0	80.5	14.5

September	22.2	21.6	20.6	20.0	12.1	10.9	98.5	36.2
October	19.2	14.3	15.6	15.4	169.9	95.8	136.1	64.0
November	13.7	12.9	11.2	11.0	14.0	39.9	35.2	73.2
December	6.4	6.2	9.3	7.3	199.5	3.9	80.3	82.7
Total					469.0	471.7	815.2	585.0
Average	19.6	15.4	15.5	14.1				

The experiment was conducted in a randomized complete block design with three replications. Plots consisted of a single row of 5 meter length. Plants were harvested at 50% flowering time. Herbage yield was recorded from a 4 m² area for each plot. 500 g fresh sample was taken from the harvested material, dried at 78 °C for 48 hours and weighed. Hay yield was calculated as dry weight percentage.

For all data obtained from this experiment, an analysis of variance was performed using the MSTAT-C software package. Significant differences among the mean values were compared by LSD test ($P \leq 0.05$) (Duzgunes et al., 1987).

Results and Discussion:-

Fresh Yield:-

Fresh yield is an important component of forage production. The results of fresh yield of meadow brome grass clones are presented in Table 2 for 2013 and 2014.

Based on the results presented in Table 2, there are significant differences ($P \leq 0.01$) for fresh yield among 31 meadow brome grass clones regardless of harvest time and year..

In 2013, the highest fresh yield (4235.67 kg/da) was determined in clone 315393-II at 1st harvest. This clone was followed by clones 536012-I, 536013-II, 315393, 536013-II and 315394. The lowest fresh yield was determined in clone 315372 at first harvest.

The highest fresh yield (660.33 kg/da) in the 2nd harvest of the *Bromus riparius* L. clones was determined in clone 315393. This clone was followed by clones 536013-I, 318343-III, 536012-III, 440207 and 315388. The lowest fresh yield was determined in clone 315676 at second harvest.

Total fresh yield of the clones varied between 669.00 – 2561.33 kg/da in the first year of the study. Clone 315393-II had the highest total fresh yield (4700.00 kg/da) in 2013. This clone was followed by clones 315393, 536012-III and 536013-II. The lowest total fresh yield was measured in clone 315372.

In 2014, the highest fresh yield was determined in clone 315393 at 1st harvest. This clone was followed by clones 440207 and 315393-II. The lowest fresh yield was measured in clone 314072 at first harvest.

In the 2nd harvest, the highest fresh yield was determined in clone 315393. This clone was followed by clones 440207 and 315393. The lowest fresh yield was measured in clone 314072-II at second harvest.

Total fresh yields of meadow brome grass clones varied between 1563.00 – 5610.67 kg/da for the second year. The highest fresh yield was determined in clone 315393 when total fresh yield of year 2014 was evaluated. This clone was followed by clones 440207 and 314514-II. The lowest total fresh yield was measured in clone 314072-II in 2014 year.

Table 2:-Fresh yield of meadow brome grass clones (kg/da) in Tekirdag conditions

Clone Number	Year 1 (2013)			Year 2 (2014)		
	1st Harvest	2nd Harvest	Total Fresh Yield	1st Harvest	2nd Harvest	Total Fresh Yield
251638	1191.33 jkl	386.67 d-j	1578.00 ijk	1737.67 g-j	1888.33 a-d	3626.00 d-k
283197	2200.00 f-j	338.00 g-j	2538.00 e-i	1977.67 f-i	1213.00 g-k	3190.67 g-l
297889	1931.00 h-k	506.67 a-g	2437.67 g-j	2500.00 b-g	1509.00 c-k	4009.00 c-i
314072	2395.67 c-j	442.33 c-j	2838.00 c-i	2273.33 e-h	1535.33 c-k	3808.67 c-i

314514	3084.33 a-i	455.33 b-1	3539.67 a-h	2173.33 e-1	1708.67 a-g	3882.00 c-1
314515	3242.33 a-h	373.33 e-j	3615.67 a-g	2342.33 e-h	1775.33 a-f	4117.67 c-h
315372	346.67 l	324.67 g-j	669.00 k	1324.67 ij	1124.33 jk	2449.00 klm
315388	3246.00 a-h	526.67 a-f	3772.67 a-g	2929.00 a-e	1237.67 g-k	4166.67 c-h
315392	2546.67 c-1	275.33 ij	2822.00 d-1	1822.33 g-j	1404.00 d-k	3226.33 g-l
315393	3682.00 a-d	660.33 a	4342.33 ab	3642.00 a	1968.67 abc	5610.67 a
315394	3413.33 a-f	431.00 c-j	3844.33 a-e	1720.00 g-j	1417.67 d-k	3131.00 h-l
315397	777.67 kl	342.33 f-j	1120.00 jk	1322.33 ij	1237.67 g-k	2560.00 j-m
315676	2604.33 b-1	257.67 j	2862.00 c-1	1362.33 ij	1035.33 kl	2397.67 lm
325232	2855.67 b-1	497.67 a-g	3353.33 b-h	2700.00 b-f	1868.67 a-e	4568.67 a-f
440207	3317.67 a-g	533.33 a-e	3851.00 a-e	3333.67 ab	2090.67 ab	5424.33 ab
440208	2622.00 b-1	291.33 hij	2913.33 c-1	1580.00 hij	1504.33 c-k	3084.33 h-l
628278	3069.00 a-1	389.00 d-j	3458.00 a-h	2393.33 d-h	1568.67 b-j	3962.00 c-1
314072-II	2290.00 e-j	271.33 ij	2561.33 e-1	1010.00 j	553.00 l	1563.00 m
314514-II	3017.67 a-1	413.33 c-j	3431.00 a-h	3242.33 a-d	1693.33a-g	4935.67 abc
315388-II	2391.00 c-j	377.67 e-j	2435.33 g-j	2240.00 e-h	1151.33 ijk	3391.33 f-l
315393-II	4235.67 a	464.33 b-h	4700.00 a	3275.67 abc	1544.00 c-k	4819.67 a-d
315394-II	2169.00 f-j	293.33 hij	2462.33 f-1	1775.33 g-j	1115.33 jk	2890.67 i-l
318343-III	2506.33 c-j	582.33 abc	3088.67 b-h	2322.33 e-h	1671.00 a-1	3993.33 c-1
440208-II	1904.67 i-k	335.67 g-j	2240.33 hij	2117.67 e-1	1349.00 e-k	3466.67 e-l
536012-I	3911.00 ab	506.67 a-g	4417.67 ab	2566.67 b-g	1813.33 a-e	4380.00 b-g
536012-II	3169.00 a-1	422.33 c-j	3801.33 a-f	2473.33 c-g	1551.00 c-k	4024.33 c-1
536012-III	2369.00 d-j	573.00 a-d	2942.00 c-h	2895.33 a-e	1675.67 a-1	4571.00 a-f
536013-I	3284.67 a-g	635.33 ab	3920.00 a-d	2480.00 b-g	2133.00 a	4613.00 a-e
536013-II	3693.33 abc	482.33 a-g	4175.67 abc	2502.33 b-g	1164.33 h-k	3666.67 d-j
536013-III	3600.00 a-e	362.00 e-j	3962.00 a-d	2884.33 a-e	1682.33 a-h	4566.67 a-f
628278-II	2051.33 g-k	475.67 a-h	2527.00 e-1	2240.00 e-h	1259.67 f-k	3499.67 e-l
LSD % 5	1320.463	187.895	1341.598	854.713	527.905	1193.917

Means bearing by same letter in column were not significantly different at the $P \leq 0.01$ level using the LSD test.

The fresh yields of *Bromus riparius* L. clones in 2014 year were higher than those of 2013. The reason for this is that the amount of total rainfall in 2014 (815.2 mm) is considerably higher than in 2013 (471.7 mm). As was also noticed in previous studies, forage yield of meadow bromegrass increased with higher precipitation (Smeal et al., 2005; Sedivec et al., 2010; St. John et al., 2012). Although an increase in fresh yield was observed in most clones in the second year, the fresh yield was lower in some clones such as 315394, 315676, 314072-II, 536012-I and 536013-II compared to the first year. These results suggest that the meadow bromegrass clones can have both different persistency and different responses to higher precipitation.

Hay Yield:-

The results of hay yields of the *Bromus riparius* L. clones are presented in Table 3. Based on the results presented in Table 3, there are significant differences ($P \leq 0.01$) for hay yield among 31 meadow bromegrass clones regardless of harvest and year.

Table 3:-Hay yield of meadow bromegrass clones (kg/da) in Tekirdag conditions

Clone Number	Year 1 (2013)			Year 2 (2014)		
	1st Harvest	2nd Harvest	Total Hay Yield	1st Harvest	2nd Harvest	Total Hay Yield
251638	420.00 ijk	111.00 d-g	531.00 gh1	538.33 g-l	617.33 a-e	1155.67 d-j
283197	815.33 d-1	100.00 efg	915.33 c-g	613.00 g-k	418.00 d-g	1031.00 g-j
297889	733.33 e-j	140.00 a-f	873.33 d-h	750.00 e-1	497.67 b-f	1247.67 d-1
314072	824.33 d-1	144.67 a-e	969.00 c-g	772.67 d-h	553.33 b-f	1326.00 b-h
314514	942.00 b-h	135.67 a-f	1077.67 b-f	652.00 f-j	591.00 b-f	1243.00 d-1
314515	948.67 b-h	115.67 c-g	1064.33 b-f	679.00 f-1	577.67 b-f	1256.67 c-1
315372	153.67 k	93.33 efg	247.00 1	383.67 kl	413.33 d-g	797.00 jk

315388	1019.67 a-h	135.67 a-f	1155.33 a-f	1024.67 a-d	402.00 d-g	1426.67 b-g
315392	847.00 c-i	84.33 fg	931.33 c-g	619.33 g-k	497.67 b-f	1117.00 e-j
315393	1434.33 a	191.00 a	1625.33 a	1238.00 a	688.67 abc	1926.67 a
315394	1006.67 a-h	140.00 a-f	1146.67 a-f	533.33 g-l	528.67 b-f	1062.00 g-j
315397	311.33 jk	99.67 efg	411.00 hi	396.67 ikl	470.67 c-f	867.33 ijk
315676	715.67 e-j	78.00 g	793.67 e-h	381.33 kl	382.33 fg	763.67 jk
325232	873.33 c-i	146.67 a-e	1020.00 b-f	810.00 c-g	711.00 ab	1521.00 a-e
440207	1300.00 abc	160.00 a-d	1460.00 ab	1053.33 abc	629.00 a-d	1682.33 ab
440208	1093.33 a-g	87.00 fg	1180.33 a-f	489.67 h-l	571.00 b-f	1060.67 g-j
628278	1084.67 a-g	109.00 d-g	1193.67 a-f	718.00 e-i	584.67 b-f	1302.67 b-h
314072-II	809.00 d-i	73.33 g	1111.33 b-f	333.00 l	207.00 g	540.00 k
314514-II	908.67 b-h	122.33 b-g	1031.00 b-f	972.33 a-e	540.00 b-f	1512.67 a-e
315388-II	702.33 f-j	111.33 d-g	813.67 e-h	694.33 f-i	391.00 efg	1085.33 f-j
315393-II	1344.33 ab	135.33 a-f	1479.67 ab	1081.00 ab	582.00 b-f	1663.00 abc
315394-II	711.00 e-j	87.00 fg	798.00 e-h	515.00 g-l	431.00 d-g	946.00 h-k
318343-III	797.67 d-i	171.00 abc	968.67 c-g	650.67 f-j	626.33 a-d	1277.00 b-i
440208-II	608.67 h-k	104.67 d-g	713.33 f-i	656.00 f-j	564.33 b-f	1220.33 d-i
536012-I	1122.00 a-f	144.33 a-e	1266.33 a-e	693.00 f-i	535.33 b-f	1228.33 d-i
536012-II	937.67 b-h	124.33 b-g	1062.00 b-f	742.00 e-i	517.67 b-f	1259.67 c-i
536012-III	848.67 c-i	175.67 ab	1024.33 b-f	897.33 b-f	593.33 a-f	1490.67 b-f
536013-I	1173.33 a-e	189.00 a	1362.33 abc	719.00 e-i	822.00 a	1541.00 a-d
536013-II	1208.67 a-d	139.67 a-f	1348.33 a-d	750.67 e-i	595.33 a-f	1346.00 b-h
536013-III	911.00 b-h	109.00 d-g	1020.00 b-f	778.33 d-h	584.33 b-f	1362.67 b-g
628278-II	635.33 g-j	137.67 a-f	773.00 f-h	694.33 f-i	457.67 def	1152.00 d-j
LSD % 5	463.823	56.370	487.104	266.216	228.832	414.302

Means with the same letter in columns are not significantly different at the $P \leq 0.01$ level using the LSD test.

In 2013, the highest hay yield (1434.33 kg/da) was determined in clone 315393 at 1st harvest. This clone was followed by clones 315393-II, 440207 and 536013-III. The lowest hay yield was measured in clone 315372 at first harvest.

The highest hay yield in the 2nd harvest of *Bromus riparius* L. clones was determined in clones 315393 (191.00 kg/da) and 536013-I (189.00 kg/da). These clones were followed by clones 536012-III, 318343-III and 440207. The lowest hay yield was measured in clone 314072-II at second harvest.

Total hay yield of clones varied between 247.00 – 1625.33 kg/da for the first year of the study. The highest hay yield (1625.33 kg/da) was determined in clone 315393 when total hay yield of year 2013 was evaluated. This clone was followed by clones 315393-II, 440207, 536013-I and 536013-II. The lowest total hay yield was measured in clone 314072-II in 2013.

In 2014, the highest hay yield (1238.00 kg/da) was determined in clone 315393 at 1st harvest. This clone was followed by clones 315393-II and 440207. The lowest hay yield was determined in clone 314072-II at first harvest.

In the 2nd harvest, the highest hay yield (822.00 kg/da) was determined in clone 536013-I. This clone was followed by clones 325232 and 315393. The lowest hay yield was measured in clone 314072-II at second harvest.

Total hay yield of the clones were between 540.00 – 1926.67 kg/da for second year of the study. The highest total hay yield (1926.67 kg/da) was determined in clone 315393 in year 2014. This clone was followed by clones 440207 and 315393-II. The lowest total hay yield was measured in clone 314072-II in year 2014.

Similar results related to hay yields of meadow brome grass have been reported by May et al. (1998), Smeal et al (2005) and Jensen et al. (2006). There was a significant difference in hay yield between the two years. Hay yield in 2014 was higher than in 2013. The reason for this may be mainly precipitation differences as indicated earlier.

Conclusion:-

Based on the results of this study, there were statistically significant differences for fresh yield and hay yield among meadow bromegrass clones. Total fresh yield of meadow bromegrass clones varied between 669.00 – 2561.33 kg/da and 1563.00 – 5610.67 kg/da in 1st and 2nd years of the study, respectively. Total hay yield of clones varied between 247.00 – 1625.33 kg/da and 540.00 – 1926.67 kg/da in 1st and 2nd years of the study, respectively. The best performing clones were determined to be clones 315393, 315393-II, 440207, 536012-III, 536013-II and 314514-II.

This study has shown that meadow bromegrass can be grown successfully as a forage crop in Trakya Region of Turkey. The clones 314514-II, 315388, 315393, 315393-II, 440207, 536012-I, 536012-III, 536013-I, 536013-II and 536013-III can be used in policrossets as parents to develop new meadow bromegrass varieties for the Thrace region conditions.

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