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Effects of Mowing Height and Biogas Digestate as a Soil Amendment on Green Quality of Strong Creeping Red Fescue (*Festuca rubra* var. *rubra*)

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A B S T R A C T

One of the most important points to be considered during establishment in lawn areas is the soil structure. Also, at this stage, the way to obtain a homogeneous, frequent and high-quality appearance is the correct and timely maintenance procedures. It is very important to adjust the mowing time and height in these maintenance operations. For this reason, in the study carried out, 3 different mowing heights were formed in the grass field facility established in the control soil and biogas digestate added. In the experiment, 2 varieties of the strong creeping red fescue (*Festuca rubra* var. *rubra*) were used as turfgrass. According to the data obtained from the experiment, it was determined that the germination speed was higher and the higher canopy percentage was earlier in the soil with biogas digestate. However, different results were obtained in terms of coverage percentage in the following periods. In terms of leaf color index, it was observed that the mowing made at a height of 75 mm had the highest value and seasonally had a higher color value in the spring season. As a result, different organic soil amendment materials can be used while establishing the lawn and depending on the type of use, the height of mowing with 50-75 mm will create a quality green for general use.

1. Introduction

Turfgrasses are easy to grow, adapt to extreme conditions, and also visually pleasing. These plants, which are known to have a lot of benefits, need to be suitable for maintenance to have an ideal appearance and to survive for many years (Emmons, 2007). In the mowing process, which is one of the most important maintenance operations, the time and height of the mowing play an important role in determining the quality of the lawn (Turgeon,1991). Mowing height varies depending on the intended use and the type (Lee et.al.). For example, this mowing height is recommended as 3-50 mm for strong creeping red fescue, but this situation may vary depending on the ecology and time (Aldous and Chivers, 2002). Strong creeping red fescue (*Festuca rubra* var. *rubra*) is a kind of grass that is resistant to drought, very high density and its color varies between light green-green. It forms a strong and durable grass layer due to the presence of rhizomes. It is also known for its resistance to shade and close shape.

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Although it is not very selective in terms of soil properties, the quality of the grass increases with the additions applied to the soil (Aldous and Chivers, 2002; Emmons, 2007), and its high resistance to diseases, which reduces the need for fungicide applications (Aamlid et al., 2012).

Biogas digestates are substances rich in minerals that are produced as a result of anaerobic fermentation of organic wastes. In addition to increasing the yield in plants, it increases the microbial activity in the soil and improves the soil properties. It also plays a role as a soil amendment because it has the same properties compared to livestock manure, which is used extensively in grass areas, as well as it contains fewer pests. (Chen et al. 2012; Makádi et al. 2012; Sürmen ve Kara, 2019). For this reason, the effects on the germination speed as a result of the use of these digestates were also examined in the study.

Turfgrasses, in particular, have an important place in this respect, where practices aimed at increasing human welfare are increasing day by day. Turfgrass establishments, especially in sports facilities and large parks, not only appeal to the visual but also have positive effects on human health. The most important factor in the longevity and quality of these facilities is maintenance work. For this reason, in this study, the effects of the mowing height and biogas digestate as soil amendment was examined.

2. Materials and Methods

The research was conducted in the district of Koçarlı in Aydın province at an altitude of 60 m in 2019-2020. The experimental area of soil was loamy and alkaline with low organic matter. Lime content of soil is 3.82%, total saline content of 0.02%, phosphorus (P) content of 35 ppm and available potassium of 320 ppm. In addition to the control plots, plots with biogas digestate (0.1 ton ha^{-1}) were created before planting in the first week of November Nitrogen, phosphorus and potassium fertilizers were applied at a rate of 75 kg ha^{-1} N, 50 kg ha^{-1} P_2O_5 and 50 kg ha^{-1} K_2O respectively, before seeding and leveling the soil with a cultivator and harrow. In the experiment, the green quality of two different varieties of strong creeping red fescue (*Festuca rubra* var. *rubra*) (Maxima, Relevant) in three different mowing heights (25,50 and 75 mm) was determined in three replications. Germination speed percentages were determined 6 and 16 days after planting to see if there is a difference in the germination of the soil to which biogas digestate was added. To determine the difference between the seasons in the coverage rate of the canopy, a mobile application called Canopeo was preferred (Patrignani and Ochsner, 2015). AL-KO HIGHLINE 46.5 P-A gasoline lawnmower was used to perform the mowing operations. The sprinkler irrigation system has been preferred for irrigation operations, and irrigation has been carried out depending on the plant water demand. The program named Field Scout Green Index was used to determine the amount of green leaf color index (Pille et al., 2011). The data obtained were analyzed using the LSD multiple comparison method in the SAS statistical package program (SAS, 1998).

3. Results and Discussion

According to the results obtained from the study, it was determined that there was faster germination in the parcels where biogas digestate was applied in terms of germination speed. In the first measurement taken 6 days after planting, 5% germination was obtained in both strong creeping red fescue varieties, while 10% germination was observed in the plots where biogas digestate was applied. When the parcels were examined 16 days after planting, it was found that there was almost complete germination in the parcels where biogas digestate was applied (Table 1.).

Table 1. Germination speed averages of *Festuca rubra* var. *rubra* varieties

	08.11.2019		**18.11.2019**	
	Control	**Digestate**	**Control**	**Digestate**
Maxima	5%	10%	75%	95%
Relevant	5%	10%	70%	90%
Mean	5%	10%	72.5%	92.5%

When the averages of the green color value obtained with the Field Scout Green Index application were examined, it was determined that the green color value obtained seasonally in the spring months was higher. While it is seen that the highest green color value in terms of mowing height is obtained from the height of 75 mm, it is thought that this is due to the large canopy of the high mown turfgrass (Table 2.). The highest values were obtained in the same height and period in both strong creeping red fescue varieties. Calvache et. al. (2017) investigated the effects of the mowing height of the mixtures of different species with red fescue (*Festuca rubra*) in their study. They stated

that although the mowing heights they have tried are at lower levels, the increase in the height of the mowing affects the lawn visual better. Robins and Bushman (2020) examined the effects of mowing height in different turfgrass mixtures in their study. Likewise, in this study, it is stated that higher mowing will provide a higher turf quality.

Table 2. Green color index (VR) averages according to seasons of *Festuca rubra* var. *rubra* varieties

***F.rubra rubra* (Maxima)**	**Soil**	**Mowing Height**			**Mean**
		25 mm	**50 mm**	**75 mm**	
Winter	**Control**	4.6	5.3	5.5	5.13
	Digestate	6.1	6.4	6.6	6.36
	Mean	5.35	5.85	6.05	5.75 B
Spring	**Control**	7.3	8.5	8.7	8.16
	Digestate	7.1	8.6	8.7	8.13
	Mean	7.20	8.55	8.70	8.15 A
Summer	**Control**	4.8	5.5	5.5	5.26
	Digestate	5.5	5.6	5.8	5.63
	Mean	5.15	5.55	5.65	5.45 C
Total Mean		5.90 C	6.65 B	6.80 A	
***F.rubra rubra* (Relevant)**	**Soil**	**Mowing Height**			**Mean**
		25 mm	**50 mm**	**75 mm**	
Winter	**Control**	5.7	6.7	6	6.13
	Digestate	5.9	6.9	7.4	6.73
	Mean	5.80	6.80	6.70	6.43 B
Spring	**Control**	7.8	8.2	8.4	8.13
	Digestate	7.7	8.1	8.5	8.10
	Mean	7.75	8.15	8.45	8.11 A
Summer	**Control**	5.5	5.9	6.2	5.86
	Digestate	5.2	5.8	6.1	5.70
	Mean	5.35	5.85	6.15	5.78 C
Total Mean		6.30 C	6.93 B	7.10 A	

If we compare the soils with biogas digestate compared to the control soils, it is seen that similar values are obtained in the Maxima variety except the value taken in the winter period. However, as a result of the statistical analysis, all double and triple interactions were found to be important (Table 2.). Lack of sufficient research for the utilization of biogas digestates in lawns creates difficulties in terms of comparing the results obtained. Andruschkewitsch et al. (2013) examined the effect of biogas digestate applied on delicate red fescue species on forage yield. Although it is stated in the study that the biogas digestate applied to the strong creeping red fescue does not make a difference, it may differ since the study is a pot study and a study for grasslands. Głowacka et al. (2020) stated that biogas wastes may have positive effects on Poaceae family. Kılıç and Türk (2017) conducted fertilization studies on tall fescue turf and stated that increasing the amount of fertilization will increase the value of leaf color index. This situation suggests that biogas waste rich in NPK content may also have positive effects.

Considering the coverage data according to the seasons, differences among the varieties were determined. In Maxima variety, the best coverage was obtained in spring, while in the Relevant variety, this value was obtained in winter, which is the planting time. At the same time, the highest value in terms of mowing heights was obtained from 75 mm height in Maxima variety, while this value was obtained from 50 mm height in Relevant variety. According to statistical analysis, there was a difference between all applications and interactions (Table 3.). It is also known that the height of the mowing has an important effect on weed control. It is reported that 4-5 cm mowing height can be ideal for Fine Fescue's (Turgeon, 1991). DeBels et al. (2012) stated in their study that the close mowing to the tall fescue causes

distortions in the green visual. This result is similar to the result we have obtained and it is seen that the close mowing harms the fescues.

Table 3. Canopy coverage averages (%) according to seasons of *Festuca rubra* var. *rubra*

***F.rubra rubra* (Maxima)**	**Soil**	**Mowing Height**			**Mean**
		25 mm	**50 mm**	**75 mm**	
Winter	**Control**	67.85	91.66	92.82	84.11
	Digestate	81.76	92.74	93.6	89.32
	Mean	74.80	92.20	93.15	86.71 B
Spring	**Control**	83.5	93.6	94.5	90.53
	Digestate	84	93.5	94.2	90.56
	Mean	83.75	93.55	94.35	90.55 A
Summer	**Control**	67.33	77.81	78.11	74.41
	Digestate	66.15	77.27	78.4	73.94
	Mean	66.74	77.54	78.25	74.17 C
Total Mean		75.09 C	87.76 B	88.58 A	
***F.rubra rubra* (Relevant)**	**Soil**	**Mowing Height**			**Mean**
		25 mm	**50 mm**	**75 mm**	
Winter	**Control**	87.77	96.46	96.31	93.51
	Digestate	85.1	96.28	96.21	92.53
	Mean	86.43	96.37	96.26	93.02 A
Spring	**Control**	82.3	97.5	97.3	92.36
	Digestate	84.2	96.8	97.1	92.70
	Mean	83.25	97.15	97.20	92.53 B
Summer	**Control**	67.56	76.46	76.31	73.44
	Digestate	68.1	76.72	76.32	73.71
	Mean	67.83	76.59	76.31	73.57 C
Total Mean		79.17 C	90.03 A	89.92 B	

4. Conclusion

Grass areas occupied an important place almost everywhere where humanity has settled in the last century. It is the most important rule of sustainability to fulfill the maintenance conditions in these areas that create quality visuals, especially in sports facilities, parks and gardens. In this respect, the effects of the mowing height and biogas digestate application on the green quality of the strong creeping red fescue grass were investigated. As a result of the research, it was determined that both varieties in the research have similar properties in terms of green color index, while some differences were observed in terms of coverage. In terms of mowing height, the highest values were obtained from 75 mm mowing height and it was observed that the green color index and coverage increased as the mowing height increased. Considering the usage purpose of the grass area, it was concluded that the mowing height of 50-75 mm would be ideal for this species. The work done is a study for the year of the facility. The examination of these and similar studies for many years will support the accuracy of the study.

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