DESERT 2021, 26(1): 55-69
DOI: 10.22059/jdesert.2020.302378.1006775

RESEARCH PAPER

Application of soil mulches on establishment and growth of native and commercial tall fescue (*Festuca arundinacea* Schreb.) in an arid environment

F. Kazemi*, M. Jozay, F. Salahshoor, H. Farhadi

Department of Horticulture and Landscape, Ferdowsi University of Mashhad, Mashhad, Kh. Razavi, Iran

Received: 7 May 2020, Revised: 6 July 2020, Accepted: 8 July 2020

Abstract
Creating sustainable landscapes especially in arid climates is a significant challenge. To achieve sustainable landscapes, some strategies such as using native plants and soil mulches have been suggested. This study aimed to examine the quality and growth response of the native tall fescue (*Festuca arundinacea* Schreb.) compared with the corresponding commercial cultivar (*Festuca arundinacea* 'Jaguar') under different planting mulches in their planting and early growth stage in arid climate Mashhad city located in the northeast of Iran. Seeds of commercial cultivar and native species of *Festuca arundinacea* were sown in a sandy loam texture soil and four mulch treatments including vermicompost, leaf compost, cow manure and sand as control, were applied to cover the seeds. The result showed that the native species had greener color and narrower leaves compared to the commercial cultivar but its other NTEP (National Turfgrass Evaluation Program) traits including density, uniformity, establishment, softness of grass surface, quality after clipping, and total quality was lower than that in the commercial cultivar. Using vermicompost as the planting mulch (top dressing or cover mulch at the time of planting of the turfgrass) significantly improved all of the traits in the native species. Vermicompost increased the percentage of grass coverage, clipping dry weight, and the plant height and decreased the leaf width of plants and number and percentage of weeds. Utilizing native species of tall fescue with vermicompost as the planting mulch can promise as quality lawn as their commercial cultivar for native urban landscaping in Iran.

Keywords: *Festuca arundinacea*; native species; planting mulch; vermicompost.

Introduction

There has been considerable research over the last 50 years which has focused on the selection of plant species through breeding or genetically modifying a single and frequently non-native species, to fulfill the demanding performance requirements and desired criteria for urban and natural landscaping (Jenkins *et al.*, 2004; Simmons *et al.*, 2011). However, depending on the location of use, several non-native grass species for turfgrass applications have been identified as invaders in urban and natural systems (Jenkins et al., 2004). Therefore, there is potential for increased economic and ecological risks associated with these improved grasses outside their origin, particularly if they become invasive in their new environment. For this reason, there has been increased attention towards the selection and propagation of native turfgrasses for use in their origin (Simmons et al., 2011). Evidence suggests native turfgrasses may be good candidates within lower maintenance or xeric landscaping projects in arid and semi-arid regions. These species have evolved under the

* Corresponding author e-mail: fatemeh.kazemi@um.ac.ir

environmental extremes of a continental climate, though a majority has not been evaluated for their suitability as a managed turfgrass (Mintenko et al., 2002).

Most grasses belong to the Poaceae family, which is one of the most extensive families of plants with a high diversity in their genus and species around the world and also in Iran (Hamzeh and Jalili, 2017). Certain native grasses, due to their high density, uniformity and drought resistance, have a remarkable ability to be utilized as urban turfgrasses (Romani et al., 2002). One of the predominant utilized cool-season perennial single turfgrasses in urban landscapes is *Festuca arundinacea* (tall fescue). The widespread use of tall fescue is a result of its adaptability to a wide range of soil and climatic conditions, its tolerance to continuous grazing, high yields of forage and seed, persistence to prolonged grazing. It also has a compatibility with varied management practices and a low incidence of pest problems and also remains green virtually all year round (Wang and Ge, 2005). Therefore, it should be viewed as a viable species to be used in sustainable landscaping in urban environments. Recently, some research work related to the native cultivars of this species in Iran for turfgrass management purposes has been published (e.g. see Nematolloahi, et al., 2018, Rabbani et al., 2019).

Achieving sustainable landscapes in arid and semi-arid climates can be obtained by applying the appropriate strategies. In addition to using native plants, another strategy for sustainable landscaping is the use of mulches at the early planting stage and during the whole period of maintenance and growth of the plants. Mulching is considered a useful technique to encourage plant growth, manage weed coverage, support nitrogen uptake, and to improve the soil water regime (Kazemi and Jozay, 2020). Soil mulching, selection of native and adapted plants are two principles of xeriscaping in arid landscape regions (Nazemi Rafi et al., 2020).

Agassi et al. (2004) reported that good quality compost could cause faster establishment of turfgrasses, improved density, color and rooting, and a reduced requirement for fertilization and irrigation. Angle et al. (1981) demonstrated the quality of the turfgrass increased with time and also with compost boosts during sod establishment. The increase in the quality rating of the turfgrass was attributed to increased amounts of nutrients from the compost. Johnson et al. (2006) showed that the use of compost could improve the quality of *Poa pratensis* grass shoot growth through a slow release of nutrients. Other studies indicate that compost mulch instigates increased nutrient and humidity levels and physical properties in the soil, and a decrease in weed coverage (Daniele et al., 2019; Dong et al., 2015; Mueller-Warrant and Rosato, 2007).

Recently, there is an increased interest in the potential of vermicomposts, which are products of a non-thermophilic biodegradation of organic materials through interactions between earthworms and microorganisms, and utilized as plant growth media and soil amendments (Villaver et al., 2019). The application of vermicompost can increase seed germination rates, stem height, number of leaves, leaf area, leaf dry weight, root length, root number, total yield, number and quality of fruits and seeds, chlorophyll content, micro- and macronutrients, carbohydrate (%) and protein (%) contents (Joshi et al., 2015).

While the effect of these mulch types has been separately examined in previous research, their influence has not been studied in a single research study. Further, no research has been found to discuss how native species versus commercial varieties perform in the presence of mulches in urban landscaping. Therefore, in this study, the effect of four mulch types on selected growth and qualitative traits of *Festuca arundinacea* 'Jaguar', a native tall fescue cultivar of Iran was compared with these traits in a generally available commercial species of *Festuca arundinacea.*

Materials and method

Site description and experimental design

This experiment was performed in the Department of Horticulture and Landscape, at the Ferdowsi University of Mashhad, in the arid city of Mashhad in Iran (59º 38′ E and 36º 16 ′ N; elevation 989 m; mean annual rainfall 255.2 mm) during spring. The average minimum and maximum mean annual temperatures were 4˚c and 22˚c, respectively (National Centers for Climatology, 2019).

The experimental design was factorial based on randomized complete block designs with three replications. Turfgrass types (two types, *Festuca arundinacea* 'Jaguar' as the commercial cultivar and a native species of *Festuca arundinacea* from Iran) and mulch types (four types, vermicompost, leaf compost, cow manure and sand as control) were used as the factors.

Plant material

The seeds of *Festuca arundinacea* 'Jaguar' as the commercial cultivar of tall fescue were sourced from, Pakan Bazr, a national seed company in Iran in spring, 2016. This cultivar was selected because it is a widely available and utilized commercial cultivar of tall fescue in Iran. The seeds of the native species were imported packages from a native seed company in Isfahan, Iran. The native species originated from Ferydon Shar city. This city is located in the west of Isfahan province, Iran, located on 32° 56′ N and 50° 7′ E. Based on the previous research (Nematolloahi, *et al., 2018, Rabbani et al.,* 2019) and local information, this species was selected as the best representative of the available native species of tall fescue in Iran.

Considering the limited number of native seed companies in Iran, this company was competent in producing the native seeds to a commercial level, when compared to seeds production from other native species. The species was an ecotype from an arid region of Iran and based on previous native research, there was a higher potential for this species to be drought resistant compared to the other available native species in Iran. There was a greater possibility to be beneficial for landscaping of a broader area of arid and semi-arid Iran.

The seeds were sown in pots (20 cm in diameter and 25 cm in depth) in spring, 2016. The pots were filled with a sandy loam texture soil. Physicochemical properties of the used soil and planting mulches are listed in Table 1. The seeds were sown in early spring and mulch treatments including vermicompost, leaf compost, cow manure, and sand, were applied to about 2 cm to cover the seeds at the propagation stage and irrigation was performed according to field capacity.

Table 1. Physicochemical properties of used soil and planting mulches

	Texture	pH	EC(ds/m)	OC (%)	N (ppm)	P (ppm)	K (ppm)
Soil	Sandy-loam	7.60	3.28	0.88	417.00	1105.00	210.00
Vermicompost	-	8.26	2.66	15.22	13589.00	4200.00	8430.00
Cow manure	-	8.11	3.93	23.41	18375.00	1.98	6.12
Leaf compost	-	7.80	3.05	20.28	15458.31	0.31	23.25
Sand (control)	-	8.60	0.56	0.13	84.00	0.10	9.58

Measured factors

Visual scoring was done based on a 1–9 scale, as suggested in the National Turfgrass Evaluation Program (NTEP) in the USA (Morris and Shearman, 2000). Score 1 indicated the weakest or the lowest value and 9 indicated the best or highest value and numbers of 6 or higher were considered as acceptable qualities. Qualitative traits that were measured with this method were including genetic color, density, texture, uniformity, and establishment, surface softness of the turfgrass after clipping, resistance to diseases, quality after clipping, and total quality.

Growth factors including height, leaf width, and the fresh and dry weight of the clipping part of a leaf were also examined. Plant height was measured using a millimeter ruler. Leaf width was measured using a digital caliper. Fresh weight was measured with a digital scale (+/- 0.01 gr), and dry weight was obtained following oven drying at about 70°C until a constant weight was achieved (Kazemi et al., 2011). Also, the chlorophyll index was measured using a manual chlorophyll meter (SPAD 502, Konica- Minohta- Tokyo). The number and percentages of weeds and canopy cover of the turfgrass were visually evaluated in each pot.

Statistical analyses

The data were subjected to analyses of variance (ANOVA) using the software package of JMP V.8. We made sure that the assumptions of ANOVA test including normality and homogeneity of variance were met before conducting the test. Comparisons of the means were conducted using Least Significant Difference (LSD) tests. The significance of between-treatment means was tested at 0.01 and 0.05 levels of probability. The bar graphs were drawn utilizing a Microsoft Excel software package.

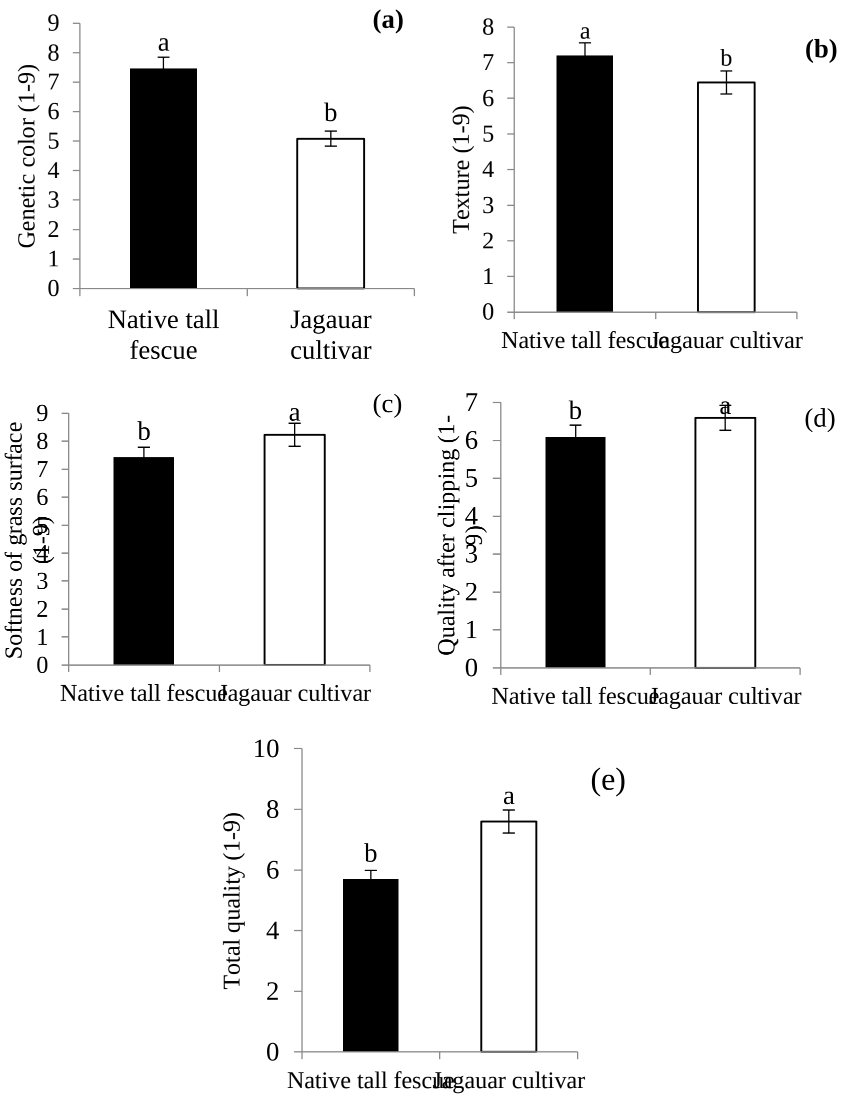
Results

According to the table of analysis of variance related to NTEP traits (Table 2), it is observed that the traits were not significant for genetic color, texture, the softness of turfgrass surface, and quality after clipping only simple effects of the turfgrass types were significant. For the trait of total quality, the interaction between the turfgrass types and mulch types was not significant, but the simple effect of the turfgrass type and mulch type was significant. That the commercial cultivar *Festuca arundinacea* ‘Jaguar’ had a significantly lower score in color (Figure 1a), coarser texture (Figure 1b), more surface softness (Figur 1c), higher quality after clipping (Figure 1d) and a total quality (Figur 1e), compared to the native species *Festuca arundinacea*.

The total quality of turfgrasses with vermicompost mulch was significantly better than that in mulches of leaf compost and sand (Figure 2). The quality of the turfgrasses when planted with vermicompost or cow manure was significantly different, and the lowest total quality of turfgrasses was obtained with sand mulch (the control treatment).

The results of the analysis of variance illustrated that the interaction between turfgrasses and mulch types on density, uniformity, and establishment were statistically significant (p<0/01) (Table 3). For the traits of resistance disease, the interactions between turfgrass types and mulch types were not significant (Table 3).

The means of interaction effects of the turfgrasses and mulch types demonstrated that *Festuca arundinacea* ‘Jaguar’ had a significantly higher density when it was associated with cow manure, leaf compost, and sand, as the types of mulches compared to the same treatment when it was applied to the native species *Festuca arundinacea*. However, the commercial cultivar did not have a significantly higher density in combination with vermicompost compared to the native species grown with vermicompost (Table 2).



Figur 1. Simple effect of the tall fescue varieties on genetic color (a), texture (b), softness of the turfgrass surface (c), quality after clipping (d) and total quality (e). Same letter in each column indicates non-significant differences

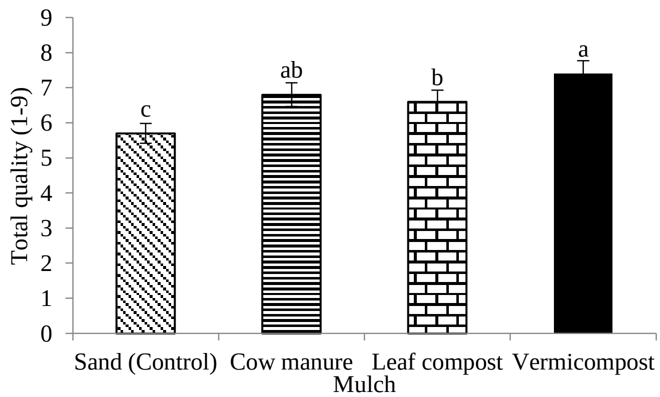


Figure 2. Simple effect of mulch types on total quality of tall fescue. Same letter in each column indicates non-significant differences

Relatively the same pattern was observed on the establishment of these two grasses in combination with the mulch types (Figure 4). For uniformity of the turfgrass, the highest scores were achieved on *Festuca arundinacea* 'Jaguar' irrespective of the type of the mulch. However, the native species achieved similar scores to the commercial cultivar when it was planted with vermicompost (Table 2). Specifically, in mulches of cow manure, leaf compost, and sand, the commercial cultivar had more density, establishment potential, and better uniformity compared to the native species. However, in vermicompost mulch, there was no significant difference between these two grasses for the three mentioned traits (Table 2).

Table 2. Comparison of the means of interactions between mulch types and tall fescue varieties

	Density (1-9)		Establishment (1-9)		Uniformity (1-9)	
	Native tall fescue	Jaguar cultivar	Native tall fescue	Jaguar cultivar	Native tall fescue	Jaguar cultivar
Sand (Control)	5.83^{c}	8.83^{a}	4.83^{d}	7.83^{ab}	5.08^{c}	6.91^{ab}
Cow manure	6.75^{bc}	8.91^{a}	5.33^{cd}	8.75^{a}	5.75^{bc}	7.58^{a}
Leaf compost	6.41^{bc}	8.83^{a}	5.75^{cd}	8.66^{a}	5.41^{c}	7.66^{a}
Vermicompost	7.83^{ab}	7.75^{ab}	6.75^{bc}	7.66^{ab}	7.25^{a}	7.16^{a}

Same letter in each column indicates non-significant differences

The results of the analysis of variance illustrated that the interaction between the turfgrasses and mulch types was significant ($p<0/01$) only for the traits of the percentage of weeds, the percentage of turfgrass coverage and dry weight of clipping. For the trait representing the number of weeds and height, the simple effect of the turfgrass types were significant ($p<0/05$ and $p<0/01$, respectively) and simple effect of mulch types ($p<0/01$ and $p<0/05$, respectively). For the trait of leaf width only the simple effect of mulch type was significant ($p<0/05$) and for traits of SPAD number and fresh weight of clipping, only the simple effect of turfgrass types were significant ($p<0/01$) (Table 4).

Means of simple effects of turfgrass types on the number of weeds indicated that the number of weeds in the *Festuca arundinacea* was significantly greater when compared to *Festuca arundinacea* 'Jaguar' (Figure 3).

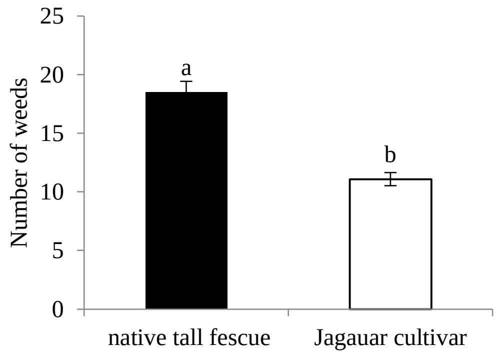


Figure 3. Simple effect of tall fescue varieties on number of weeds. Same letter in each column indicates non-significant differenc

Table 3. Analysis of variance (mean of squares) related to NTEP traits of native and commercial tall fescue under different mulches

Source of variation	df	Mean of squares								
		Genetic color	Density	Texture	Uniformity	Establishment	Softness of grass surface	Resistance to diseases	Quality after clipping	Total quality
Turfgrass	1	34.32**	21.09**	3.45**	12.76**	39.39**	3.92**	0.04ns	1.04*	21.56**
Mulch	3	0.17ns	0.30ns	0.08ns	1.47**	1.04*	0.009ns	0.04ns	0.43ns	2.86**
Block	2	0.05ns	0.04ns	0.24*	0.34ns	0.09ns	0.05ns	0.04ns	0.01ns	0.05ns
Turfgrass× mulch	3	0.02ns	2.73**	0.04ns	1.64**	1.87**	0.005ns	0.04ns	0.09ns	0.30ns
Error	14	0.10	0.31	0.06	0.20	0.26	0.03	0.04	0.14	0.19
cv		3.54	7.33	2. 21	6.92	7.33	1.78	2.27	5.85	6.57

Table 4. Analysis of variance (mean of squares) related to some morphological traits of native and commercial turfgrasses under different mulches

Source of variation	df	Mean of squares							
		Number of weeds	Weeds (%)	Turfgrass coverage (%)	Leaf width (mm)	SPAD	Fresh weight of clipping (gr)	Dry weight of clipping (gr)	Height (cm)
Turfgrass	1	330.04*	100.04**	2400.00**	0.01ns	109.22**	1061.50**	11.44**	27.09**
Mulch	3	1122.81**	252.59**	756.94**	0.24*	6.58ns	17.00ns	0.93**	4.78*
Block	2	28.16ns	0.04ns	40.62ns	0.01ns	3.02ns	17.83ns	0.25ns	0.96ns
Turfgrass× mulch	3	62.70ns	39.59**	386.11**	0.03ns	13.93ns	10.86ns	0.91**	0.59ns
Error	14	56.92	3.23	10.86	0.04	9.87	5.49	0.10	1.23
cv		9.33	2.28	23.94	10.06	9.62	22.41	9.09	24.73

* , **and ns: significant at probability level of 1% , 5% and non-significant, respectively

Means of the simple effect of mulch type on the number of weeds revealed that the highest number of weeds were related to leaf compost mulch, and there were no significant differences between the other types of mulches (Figure 4).

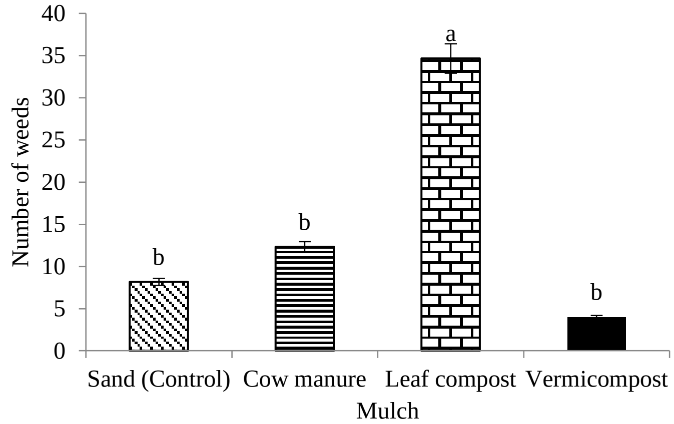


Figure 4. Simple effect of mulch types on number of weeds. Same letter in each column indicates non-significant differences

Means of interaction effects of the turfgrass and mulch type on the percentage of weeds showed that the highest percentage of weeds was related to leaf compost mulch in both the *Festuca arundinacea* 'Jaguar' and *Festuca arundinacea*. The other mulches, on the *Festuca arundinacea* 'Jaguar', did not have a significant effect on this trait. In the *Festuca arundinacea*, the sand mulch (control treatment) had a higher percentage of weeds compared to the percentage of weeds on cow manure and vermicompost mulches (Figure 5).

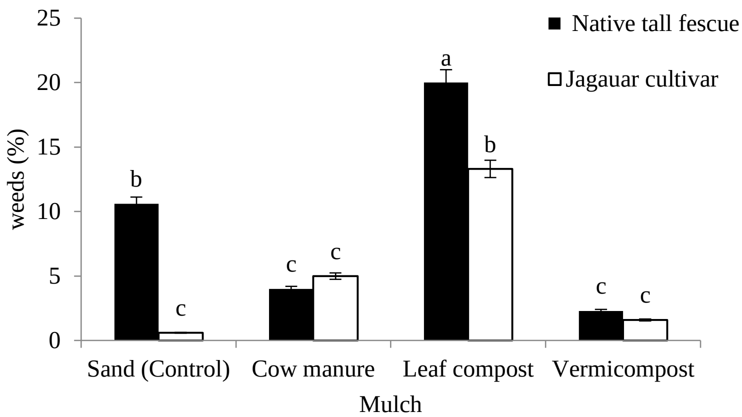


Figure 5. Comparison of the means of interactions between mulch types and tall fescue varieties on percentage of weeds. Same letter in each column indicates non-significant differences

Means of interaction effects of the turfgrass and mulch type on the percentage of the turfgrass coverage demonstrated that different mulches on the percentage of the turfgrass coverage did not have any significant difference for *Festuca arundinacea* 'Jaguar'. Despite this result, in the native species *Festuca arundinacea*, higher percentages of turfgrass coverage were obtained in a combination of the mulches of vermicompost, cow manure, leaf compost, and sand, respectively. In vermicompost mulch, between the two types of grasses, the commercial and native, there were no significant differences, and this mulch was associated with the highest percentage of turfgrass coverage (95%) for both grass types (Figure 6).

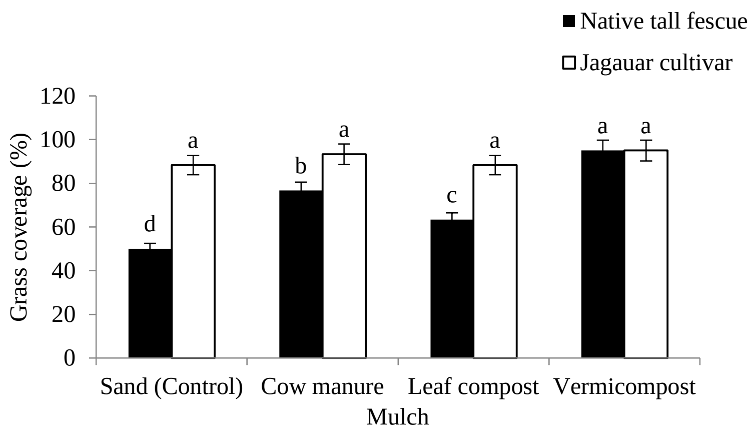


Figure 6. Comparison of the means of interactions between mulch types and tall fescue varieties on percentage of turfgrass coverage. Same letter in each column indicates non-significant differences

Means of the simple effect of mulch types on leaf width showed that cow manure mulch was associated with widest leaves in the turfgrass types. The leaves of the plants associated with cow manure were significantly different from the leaves of the grasses associated with vermicompost mulch, i.e. both Fescue types in vermicompost mulch had the narrowest leaves (Figure 7).

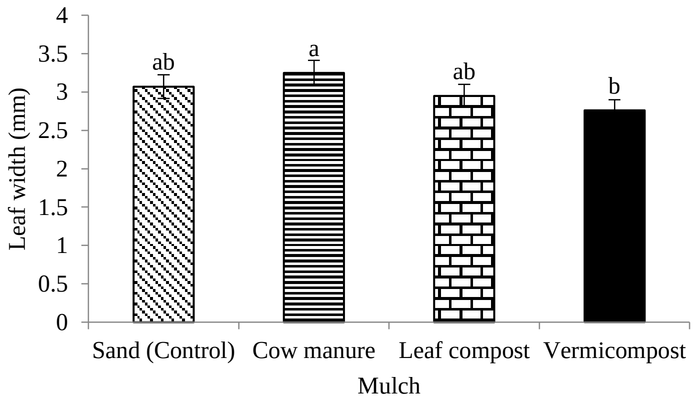


Figure 7. Simple effect of mulch types on leaf width. Same letter in each column indicates non-significant differences

The simple effect of turfgrass types on SPAD number (chlorophyll index) revealed that *Festuca arundinacea* had a significantly higher SPAD number than *Festuca arundinacea* ‘Jaguar’ (Figure 8).

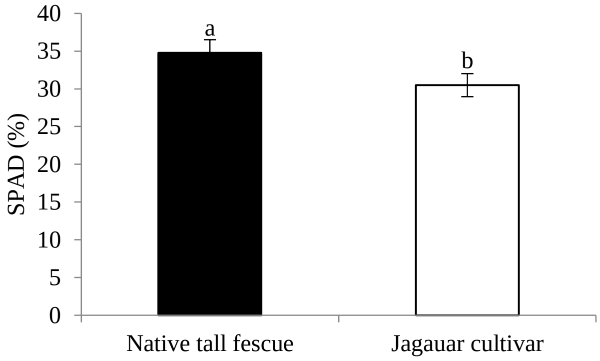


Figure 8. Simple effect of tall fescue varieties on SPAD number. Same letter in each column indicates non-significant differences

The fresh weight of the clipping part of the turfgrasses, it was observed that *Festuca arundinacea* 'Jaguar' had significantly more fresh weight compared to *Festuca arundinacea* (Figure 9).

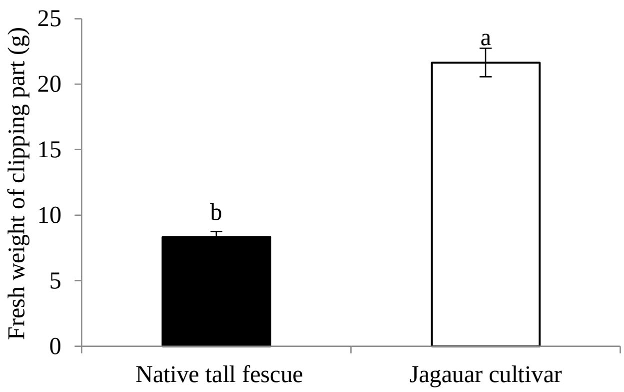


Figure 9. Simple effect of tall fescue varieties on fresh weight of clipping part. Same letter in each column indicates non-significant differences

Means of interaction effects of the turfgrass and mulch types on the dry weight of the clipping part showed that different mulch types did not have any significant difference for this trait in *Festuca arundinacea* 'Jaguar'. In *Festuca arundinacea*, there were no significant differences among cow manure, leaf compost mulches, and sand regarding the dry weight of clipping but vermicompost mulch resulted in a significant increase in dry weight of clipping part. *Festuca arundinacea* 'Jaguar' had more dry weight compared to the dry weight in *Festuca arundinacea* under different mulches, though in vermicompost mulch, there was no significant difference between the two tall Fescue types (Figure 10).

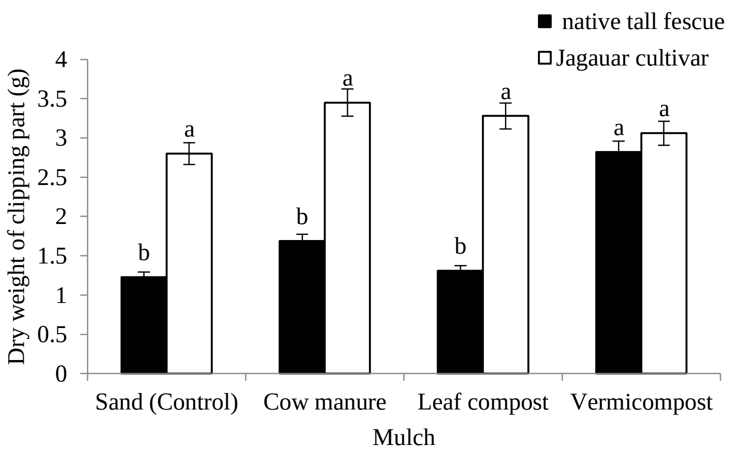


Figure 10. Comparison of the means of interactions between mulch types and turfgrass varieties on dry weight of clipping part. Same letter in each column indicates non-significant differences

Means of the simple effect of turfgrass on the height of the plants showed that the commercial *Festuca arundinacea* 'Jaguar' had significantly larger height compared to the *Festuca arundinacea* (Figure 11).

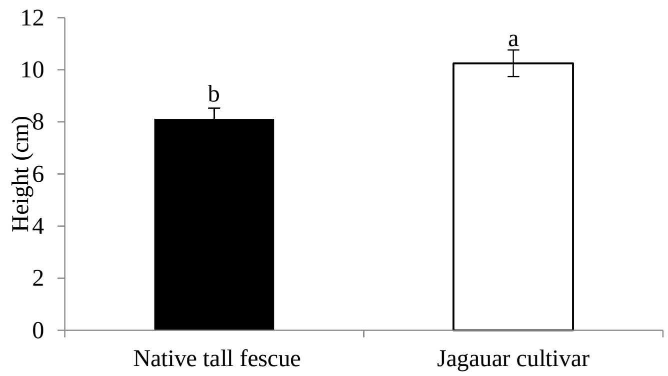


Figure 11. Simple effect of tall fescue varieties on height. Same letter in each column indicates non-significant differences

Means of the simple effect of mulch types on the height of the plants showed that the lowest height was related to the sand mulch (control treatment), and the largest height of the turfgrasses was related to the vermicompost mulch. There was no significant difference regarding this trait between the other two mulch types (Figure 12).

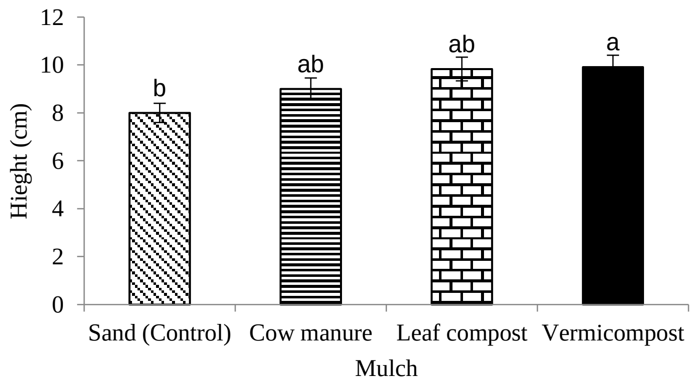


Figure 12. Simple effect of mulch types on height. Same letter in each column indicates non-significant differences

Discussion

The results showed *Festuca arundinacea* 'Jaguar' had enhanced values for NTEP traits than the native species (*Festuca arundinacea* Shrenb.), except for the traits of genetic color and texture. Visual quality may not be sufficient without due attention to the other measurements, because visual rating systems are subjective, and consequently, the results they produce could be inconsistent (Salehi and Khosh-Khui, 2004). However, Beard (1973) suggested that utilizing visual qualify as the best procedure for selection between turfgrasses and Cooper and Spokas (1991) stated that color is the most important characteristic that contribute to visual turfgrass quality. In this study, it was observed that the *Festuca arundinacea* had fine leaves with a stronger green color, which makes this species more attractive than its corresponding cultivar *Festuca arundinacea* 'Jaguar'.

Our results show that chlorophyll index (SPAD number) in the *Festuca arundinacea*, was higher than the number in the *Festuca arundinacea* 'Jagauar'. Similar to genetic color, this factor also indicates that the native species had a better green color than its corresponding commercial cultivar. The effect of mulches was not significant for this trait, and this result is in contrast with findings of Papathanasiou et al. (2012), indicated the application of vermicompost caused a significant increase in the chlorophyll index of lettuce leaves in spring.

It was also observed that density, establishment, and uniformity of a commercial cultivar were higher than these factors in the native species. Competition of non-native species may interfere with the establishment of the native species. Non-native species can colonize natural areas, preventing the establishment of native species (Jenkins et al., 2004). From this aspect, our results are consistent with the results of Simmons et al. (2011) in that native species can have slower growth rates compared to the non-native species. However, in the present study, vermicompost mulch improved density, establishment, and uniformity of the *Festuca arundinacea* to be equal to these attributes in its Jaguar cultivar. These trends were also observed for the number of weeds. Weed suppression is a function of leaf density (Simmons et al., 2011), when the number of weeds are low, the density, establishment, and uniformity are high. The composting of organic materials can significantly reduce the viability of weed seeds (Eghball and Lesoing, 2000). During the composting process, probably, microbial activities increase, and electrical conductivities decrease and these conditions cause faster establishment of desired plants and make it possible to prevent weed incursion (Stoffella and Kahn, 2001). Vermicomposts are finely-divided matured peat-like materials with a high porosity, aeration, drainage, and water-holding capacity and microbial activity, which are stabilized by interactions between earthworms and microorganisms in a non-thermophilic process (Arancon et al., 2004b). Also, composting has some agronomic benefits, including a reduction in material mass and water content, pathogen suppression, decreased weed seed viability, and the production of a stabilized organic material that is easier to handle and spread (Johnson et al., 2006). In our study, the number and percentage of weeds were the lowest in vermicompost mulch but in leaf compost mulch it was the highest.

In this study, the quality after clipping and total quality of *Festuca arundinacea* 'Jagauar' was higher than these factors in the corresponding *Festuca arundinacea.* The best total quality of the turfgrass among mulches was observed in vermicompost, and the lowest quality was related to sand (control treatment). Compost retains most of the original nutrients and has reduced levels of organic contaminants (Gutie´rrez-Miceli et al., 2007) which are important in maintaining the quality of the plants. In the present study, it was observed that the width of leaves in vermicompost mulch was narrower than that in the sand mulch. Increasing leaf width may increase transpiration and reduce the elegance of grass leaves. Also decreasing the leaf width enhanced the quality of the turfgrass. Plant height in the *Festuca arundinacea* 'Jaguar' with a mean of 2.13 cm was greater than the height in the corresponding *Festuca arundinacea*, and among the mulches, vermicompost produced the greatest height in the turfgrasses. Pyvast et al. (2008) also showed that the height of Spinach plants grown in vermicompost mixtures was higher compared to the control non-vermicompost planted spinaches.

The fresh weight of clipping was significantly different in the two turfgrass types, while the different mulches did not have any effect on this trait. However, an application of vermicompost appeared to be responsible for more percentage of turfgrass coverage and higher clipping dry weight in the *Festuca arundinacea*. Probably the use of vermicompost improved the physical, chemical, and biological characteristics of the soil and resulted in easier absorption of water and nutrition elements which are essential for vital synthetic and metabolic processes (Sohrabi Yourtchi et al., 2013). Similar results were reported by Anwar et al. (2005). This can also be better understood comparing the amount of N, P, K, and organic carbon in vermicompost and sand as demonstrated in table 1. In this study, vermicompost appears that has acted as a rich source of nutrients and the richest source of P and K among the studied mulches. Several studies have confirmed the major positive effects of phosphorous and potassium fertilizers on early growth and establishment of plants and even in facilitating the uptake of other nutrients (Andrew, 1960; Andew and Robins, 1969; Mallarino et al., 1999). The greater phosphorus availability by mulching may be attributed to increased activity of phosphorus solubilizing bacteria and fungi in soil. The second reason may be that mulching tends to increase the downward movement of phosphorus and decreased the amount of phosphorus fixed by the soil (Gaur and Mukherjee, 1980). Also, Haggar et al. (1991) showed that higher availability of P was maintained by the release of P from the mulch and not from the soil. Compared to conventional composts, vermicompost has a much finer structure and larger surface area providing strong absorbability and retention of nutrients (Zaller, 2007). From this respect, this result is in agreement with Duong et al. (2012) who found that the stronger effect on soil and plant properties of the finer-textured composts compared to the coarser textured mulches can be explained by the higher surface area to volume ratio of the former. The larger surface area would not only increase the contact area with water and thus leaching of nutrients and salts from the mulch layer into the soil but also the accessibility to soil and compost microbes. Nutrients such as nitrates, exchangeable phosphorus, potassium, calcium, and magnesium in vermicompost are present in readily available forms for plant uptake. Additionally, vermicompost contains substances that stimulate and regulate plant growth (Singh and Nain, 2014). Vermicompost contains plant growth regulators and other plant growth-influencing materials produced by microorganisms (Arancon et al., 2004). Jozay et al. (2019) also showed that vermicomposts have the potential for improving the growth of ground cover plants when it was used as a substrate amender in green wall systems.

Conclusion

This experiment demonstrated the use of vermicompost improved conditions for turfgrass growth, establishment, density, uniformity, clipping dry weight, the slenderness of leaves, and total quality of native and commercial types of tall fescue. The application of vermicompost resulted in the native species *Festuca arundinacea* to present the best measured traits when compared with its corresponding commercial cultivar *Festuca arundinacea* 'Jaguar'. The native species of tall Fescue in this study was showier than its corresponding commercial cultivar, because of its greener and finer leaves. Though *Festuca arundinacea* could not compete in some of the desired quality factors associated with its corresponding *Festuca arundinacea* 'Jaguar', this could be addressed if it was planted with the most appropriate planting mulch. However, vermicompost as a low-cost mulch in conjunction with the *Festuca arundinacea* could be applied for commercialization of planting native tall Fescue to implement low- input and sustainable urban landscapes in Iran.

Acknowledgements

We thank the laboratory of the Department of Horticulture of Agriculture Faculty of Ferdowsi University of Mashhad for providing required materials and equipment. We also highly appreciate Dr. Mark Daker for precise reviewing the last version of this manuscript.

References

Agassi M, Levy GJ, Hadas A, Benyamini Y, Zhevelev H, Fizik E, Gotessman M, Sasson N. 2004. Mulching with composted municipal solid wastes in central Negev, Israel: I. effects on minimizing rainwater losses and on hazards to the environment. Soil and Tillage Research, 78; 103-113.

Andrew CS. 1960. The effect of phosphorus, potassium, and calcium on the growth, chemical composition, and symptoms of deficiency of white clover in a subtropical environment. Australian Journal of Agricultural Research, 11; 149-161.

Andrew CS, Robins MF. 1969. The effect of potassium on the growth and chemical composition of some tropical and temperate pasture legumes. I. Growth and critical percentages of potassium. Australian Journal of Agricultural Research, 20; 999 -1007.

Angle JS, Hall JR, Wolf D.C. 1981. Turfgrass growth aided by sludge compost. BioCycle, 2; 40-43.

Anwar M, Patra DD, Chand S, Alpesh K, Naqvi AA, Khanuja SPS. 2005. Effect of organic manures and inorganic fertilizer on growth, herb and oil yield, nutrient accumulation, and oil quality of French Basil. *Commun.* Soil Science and Plant Analysis, 36; 1737-1746.

Arancon NQ, Edwards CA, Bierman P, Welch C, Metzger JD. 2004. Influences of vermicomposts on field strawberries: 1. effects on growth and yields. Bioresource Technology, 93; 145-153.

Beard JB. 1973. Turfgrass: science and culture. Prentice-Hall, Inc., Englewood Cliffs, N.J.

Cooper RJ, Spokas LA. 1991. Growth, quality and foliar iron concentration of Kentucky bluegrass treated with chelated iron sources. Journal of the American Society for Horticultural Science, 116; 798-801.

Daniele M, Benvenuti S, Cacini S, Lazzereschi S, Burchi G. 2019. Effect of hydro-compacting organic mulch on weed control and cropperformance in the cultivation of three container-grown ornamental shrubs: Old solutions meet new insights. Scientia Horticulturae, 252; 260-267.

Dong Y, Lei T, Li SH, Yuan C, Zhou SH, Yang Z. 2015. Effects of rye grass coverage on soil loss from loess slopes. . International Soil and Water Conservation Research, 3; 170-182.

Duong TTT, Penfold C, Marschner P. 2012. Amending soils of different texture with six compost types: impact on soil nutrient availability, plant growth and nutrient uptake. Plant and Soil, 354; 197-209.

Eghball B, Lesoing GW. 2000. Viability of weed seeds following manure windrow composting. Compost Science and Utilization, 8; 46-53.

Gaur AC, Mukherjee D. 1980. Recycling of organic matter through mulch in relation to chemical and microbiological properties of soil and crop yields. Plant and Soil, 56; 273-281.

Gutie´rrez-Miceli FA, Santiago-Borraz J, Montes Molina JA, Nafate NN, Abud-Archila M, Oliva-Llaven MA, Rinco´n-Rosales R, Dendooven L. 2007. Vermicompost as a soil supplement to improve growth, yield and fruit quality of tomato (*Lycopersicum esculentum*). Bioresource Technology, 98; 2781-2786.

Hagaar JP, Warren GP, Beer JW, Kass D. 1991. Phosphorus availability under alley cropping and mulched and unmulched sole cropping systems in Costa Rica. Plant and Soil, 137; 275-283.

Hamzeh B, Jalili A. 2017. The importance of Poaceae in nature and human life. Iran Nature, 46-55.

Jenkins AM, Gordon DR, Renda MT. 2004. Native alternatives for non-native turfgrasses in Central Florida: germination and responses to cultural treatments. Restoration ecology, 12; 190-199.

Johnson GA, Qian YL, Davis JG. 2006. Effects of compost topdressing on turf quality and growth of Kentucky bluegrass. Online. Applied Turfgrass Science.

Joshi R, Singh J, Pal Vig A, 2015. Vermicompost as an effective organic fertilizer and biocontrol agent: effect on growth, yield and quality of plants. Environmental Science and Biotechnology Technology, 14; 137-159.

Jozay M, Kazemi F, Fotovat A. 2019. Evaluating the environmental performance of the growing media in a green wall system in a dry climate region. Desert, Acceptance date: 2019.12.24.

Kazemi F, Jozay M. 2020. The effect of organic and inorganic mulches on growth and morphophysiological characteristics of *Gaillardia* sp.. Desert, Acceptance date: 2020.02.15.

Kazemi F, Beecham S, Gibbs J. 2010. Streetscape biodiversity and the role of bioretention swales in an Australian urban environment. Landscape and Urban Planning, 101; 139-148.

Mallarino AP, Bordoli JM, Borges R. 1999. Phosphorus and potassium placement effects on early growth and nutrient uptake of no-till Corn and relationships with grain yield. Agronomy Journal, 91; 37-45.

Mintenko AS, Smith SR, Cattani DJ. 2002. Turfgrass evaluation of native grasses for the northern Great Plains region. Crop Science, 42; 2018–2024.

Morris, K.N., R.C. Shearman, 2000. NTEP Turfgrass Evaluation Guidelines. www.ntep.org/pdf/ratings. 2013/5/30.

Mueller-Warrant GW, Rosato SC 2005. Weed control for tall fescue seed production and stand duration without burning Crop Science, 45; 2614-2628.

National Centers for Climatology, 2019, Climate information of the city of Mashhad, available on: https://www.ncdc.noaa.gov/climate-information, access date: 2019.07.25.

Nazemi Rafi Z, Kazemi F, Tehranifar A. 2020. Public preferences toward water-wise landscape design in a summer season, Urban Forestry and Urban Greening, 48, DOI: 10.1016/j.ufug.2019.126563.

Nematollahi F, Tehranifar A, Nemati SH, Kazemi F, Gazanchian A. 2018. Improving early growing stage of Festuca arundinacea Schreb. using media amendments under water stress condition, Desert, 23(2) 295-306.

Papathanasiou F, Papadopoulos I, Tsakiris I, Tamoutsidis E. 2012. Vermicompost as a soil supplement to improve growth, yield and quality of lettuce (*Lactuca sativa* L.). Journal of Food, Agriculture and Environment, 10; 677-682.

Peyvast Gh, Olfati JA, Madeni S, Forghani A. 2008. Effect of vermicompost on the growth and yield of spinach (*Spinacia oleracea* L.). Journal of Food, Agriculture and Environment, 6; 110-113.

Rabbani M, Kazemi F, Shoor M. 2019. Evaluating the effect of superabsorbents moisture and physiological characteristics of *Lolium perenne* L. ‘Chadegan’ and *Festuca arundinacea*. Desert, 24-2, 229-240.

Romani M, Piano E, Pecetti L. 2002. Collection and preliminary evaluation of native turfgrass accessions in Italy. Genetic Resources and Crop Evolution, 49; 341-349.

Salehi H, Khsh-Khui M. 2004. Turfgrass monoculture, cool-cool, and cool-warm season seed mixture establishment and growth responses. Horticultural Science, 39; 1732-1735.

Simmons M, Bertelsen M, Windhager S, Zafian H. 2011.The performance of native and non-native turfgrass monocultures and native turfgrass polycultures: An ecological approach to sustainable lawns. Ecological engineering, 37; 1095-1103.

Singh S, Nain L. 2014. Microorganisms in the conversion of agricultural wastes to compost. Proceedings of the Indian National Science Academy, 80; 473–481.

Sohrabi Yourtchi M, Haj Seyyed Hadi M, Darzi MT. 2013. Effect of nitrogen fertilizer and vermicompost on vegetative growth, yield and NPK uptake by tuber of potato (Agria CV.). International Journal of Agriculture and Crop Sciences, 5; 2033-2040.

Stoffella PJ, Kahn BA. 2001. Compost utilization in horticultural cropping system. CRC. Press, USA.

Villaver JP, Panlaan RA, Tangalin MGG. 2019. Perceptions of Vermi Raisers on Different Vermicomposting Practices Adopted in Zamboanga Del Sur, Philippines. International Journal of Science and Management Studies, 2(4); 2581-5946.

Wang ZY, Ge Y. 2005. Agrobacterium-mediated high efficiency transformation of tall fescue (*Festuca arundinacea*). Journal of Plant Physiology, 162; 103-113.

Zaller JG. 2007. Vermicompost as a substitute for peat in potting media: Effects on germination, biomass allocation, yields and fruit quality of three tomato varieties, Scientia Horticulturae, 112; 191–199.