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Effect of Addition of Sand and Soil Amendments to Loam and Brick Grit Media on the Growth of Two Turf Grass Species (*Lolium perenne* and *Festuca rubra*)

M.R. Alhajhoj Al-Qahtani
Department of Horticulture, King Faisal University, P.O. Box 55031, Al-Ahsa, 31982, Saudi Arabia

Abstract: This greenhouse study evaluated the effect of the soil amendments, such as sand, Clinoptilolite Zeolite (CZ) and moler (calcined clay) on the germination and growth of two cool season turf grass species namely *Lolium perenne* and *Festuca rubra*. The germination was significantly better with the application of clinoptilolite than moler for both the turf grass species. Although, the addition of sand did not affect the germination rate of any specie, but the fresh and dry weight of turf grass species decreased with the increasing proportion of sand in the growing media ($p<0.001$). Overall, the addition of moler to the growing mixture provided better growth for both the turf grass species. Further research is required for detailed investigation on the physical and chemical role of different soil amendments in the growing mixture to obtain normal plant establishment in landscape and play grounds under arid climatic conditions.

Key words: Turf grass species, sand, clinoptilolite (zeolite), moler (calcined clay), germination, growth, dry and fresh weight

INTRODUCTION

Festuca rubra and *Lolium perenne* are turf grass species commonly used in athletic sites and areas receiving traffic (Carrow, 1980). The sandy beds are specified for sports courses even under heavy traffic, because the sand resists compaction and maintains drainage. Although, the nutrient and water retention is generally poor and soluble nutrients are prone to leaching (Bigelow *et al*., 2001). In order to overcome the above problems, various inorganic amendments such as clinoptilolite (Huang and Petrovic, 1994) and calcined clays (Nus, 1984) have been added to the growing medium. Research indicated that clinoptilolite provided significantly better rates of germination and growth of various plants (Al-Gahtany and Alhajhoj, 2001; Leggo, 2000). On the other hand, moler (calcined clay) has been effective in increasing air porosity and permeability when added to sand (Waddington, 1992). The aim was to study the influence of addition of sand and soil amendments in soil media to determine the germination and growth of two common turf grass species.

MATERIALS AND METHODS

The experiment was carried out in a greenhouse at the Agricultural and Veterinary Training and Research Station, King Faisal University, Al-Ahsa, during 2006 and 2007. The research station is located about 20 km away from the main town Hofuf on main Hofuf-Qatar Highway. The greenhouse is facilitated with full controlled environment.

The experimental treatments included (1) two cool season turf grass species (*Festuca rubra* and *Lolium perenne*), (2) three sand levels i.e., 0, 25 and 50% and (3) three soil amendments (addition of 0, 5 and 10% of sand, clinoptilite Zeolite and moler: a calcined clay, respectively). There were four replications. The seeding rate was 0.5 g of seed of each specie per pot.

A potting mixture of 90% b.v loam and sand and of either 10% of CZ or moler with brick grit was prepared and mixed with NPK (10-7,5-10,2) fertilizer and trace elements at rate of 0.55 g pot^{-1}. The pots were placed in the controlled environment greenhouse where the inside temperature was maintained around 15°C from. The germination data was recorded on 8th and 18th days after sowing. The fresh and dry weight were taken as two harvests for each species i. e., 28 and 44 days after sowing for *Lolium perenne* and 33 and 51 days after sowing for *Festuca rubra*. Data were analyzed using the statistical package SAS (6.0).

RESULTS

Germination

***Festuca rubra*:** The addition of sand did not significantly affect the germination rate of grass seed 8 days after sowing (Table 1). Whereas, the application of soil amendments (clinoptilolite and moler) significantly affected the grass seed germination ($p<0.001$). The

Table 1: Effect of sand and soil amendments (clinoptilolite and moler) on growth parameters of turf grass specie *Festuca rubra*

	Germination		Fresh weight		Dry weight	
Growth media	1st	2nd	1st	2nd	1st	2nd
Sand	NS	NS	NS	p<0.001	NS	p<0.001
Amend	p<0.001	NS	NS	p<0.01	NS	p<0.01
Sand amend	p<0.05	NS	p<0.05	NS	p<0.05	NS

NS: Non significant

Table 2: Effect of sand and soil amendments (clinoptilolite and moler) on growth parameters of turf grass specie *Lolium perenne* (ANOVA)

	Germination		Fresh weight		Dry weight	
Growth media	1st	2nd	1st	2nd	1st	2nd
Sand	NS	NS	p<0.01	p<0.001	p<0.01	p<0.001
Amend	NS	p<0.01	NS	p<0.001	NS	p<0.01
Sand amend	NS	NS	NS	NS	NS	NS

NS: Non significant

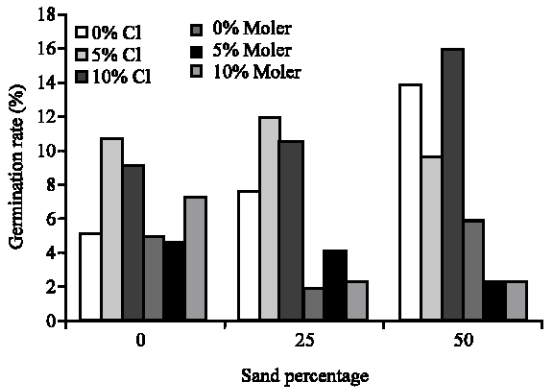

Fig. 1: Effect of sand and soil amendments on the germination of *Festuca rubra* after 8 days of seed sowing

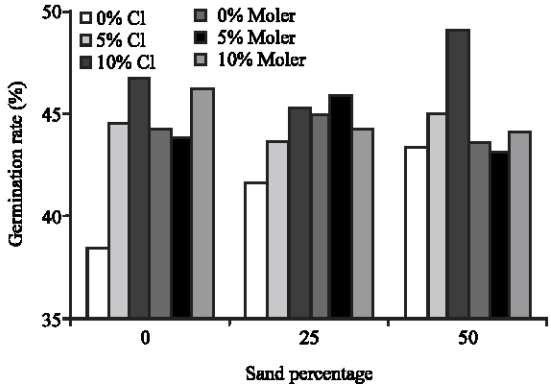

Fig. 2: Effect of sand and soil amendments on the germination of *Lolium perenne* after 18 days of seed sowing

interaction between sand and the soil amendments (clinoptilolite and moler) was significant on seed germination (p<0.05). However, the sand and soil amendments application did not significantly affect the seed germination 18 days after sowing. Similarly, the interaction between sand and soil amendments did not show any significant effect on the seed germination rate. Although, the final germination rate in the clinoptilolite treated pots did not differ significantly from the moler application 8 days after sowing but the seed germination was highly favorable to the application of clinoptilolite. The effect of both the clinoptilolite and moler application to the sowing mixture on the germination rate varied with the change in the percentage of sand addition (Fig. 1).

***Lolium perenne*:** The results for the effect of addition of sand and soil amendments to growing media on the seed germination of *Lolium perenne* grass specie were similar to that of *Festuca rubra* when analyzed after 8 days of sowing. This means that the addition of sand and the soil amendments as well as their interaction (between sand and soil amendments) did not significantly affect the seed germination rate after 8 days of sowing. However, after 18 days of seed sowing, the application of soil amendments significantly (p<0.01) affected the seed germination rate (Table 2).

The data further indicate that addition of 10% clinoptilolite to the growing media produced the highest seed germination after 18 days of sowing but was not significantly different from 5% clinoptilolite treatment and all the moler treatments. However, the growing mixtures with control treatment (0% clinoptilolite) significantly showed the lowest rate of seed germination and was different from all other treatments (Fig. 2).

Fresh weight

***Festuca rubra*:** There was no significant difference in the mean fresh weight either in the sand or the soil amendments application after 33 days of sowing. The interaction between the sand and soil amendments was significant on the mean fresh weight at p<0.05 after 51 days of sowing (Table 1). But the addition of sand and soil amendments to the growing media significantly affected the mean fresh weight of grass at p<0.001 and p<0.01, respectively.

Addition of sand to the growing media significantly affected the mean fresh weight of turf grass (Fig. 3). The control treatment (0% sand) gave the highest fresh weigh as compared to other sand treatments. The difference in yield was not significant from 25% sand treatment but it was significant from 50% sand treatment which produced the lowest mean fresh weight.

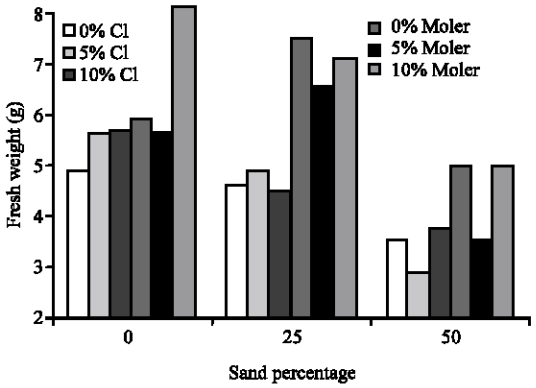

Fig. 3: Effect of sand and soil amendments on the fresh weight of *Festuca* rubra after 51 days of seed sowing

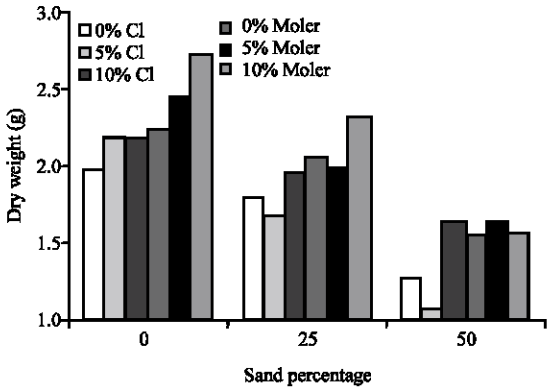

Fig. 4: Effect of sand and soil amendments on the fresh weight of *Lolium perenne* after 44 days of seed sowing

Table 3: Comparison of soil treatments (clinoptilolite and moler) effect on the mean fresh weight and dry weight of *Festuca rubra*

	%		
Soil amendment	0	5	10
Fresh weight (g)			
Clinoptilolite	4.355c*	4.481c	4.637c
Moler	6.122ab	5.222bc	6.730a
LSD ($p<0.01$) =1.392			
Dry weight (g)			
Clinoptilolite	1.015c*	1.065bc	1.097bc
Moler	1.300ab	1.220bc	1.503a
LSD ($p<0.01$) = 0.259			

Mean values followed by the same letter(s) are not significantly different at $p<0.01$

Table 4: Comparison of soil treatments (clinoptilolite and moler) effect on the mean fresh weight and dry weight of *Lolium perenne* (2nd Harvest)

	%		
Soil amendment	0	5	10
Fresh weight (g)			
Clinoptilolite	7.526b*	7.416b	9.143a
Moler	9.049a	8.837a	9.811a
LSD ($p<0.001$) =1.138			
Dry weight (g)			
Clinoptilolite	1.684c*	1.648c	1.923b
Moler	1.953b	2.027ab	2.198a
LSD ($p<0.001$) = 0.214			

Values followed by the same letter(s) are not significantly different at $p<0.001$

A comparison showed that among all the soil amendment treatments, the growing mixtures with 10% moler produced the highest mean fresh weight which was significantly different from 5% moler treatment and all the clinoptilolite treatments (Fig. 3, Table 3).

***Lolium perenne*:** The addition of sand to the growing media significantly affected the mean fresh weight ($p<0.01$) after 28 days of sowing. However, soil amendments did not show any significant effect on mean fresh weight. Also, there was no interaction between the sand and the soil amendments on the mean fresh weight (Table 2). The data also revealed that the addition of sand and the soil amendments significantly ($p<0.001$) affected the mean fresh weight after 44 days of sowing (Table 2).

The control treatment (0% sand) gave the highest mean fresh weight and was significantly different from 25 and 50% sand treatments. Among all the treatments, 5% moler application produced better yield of fresh weigh as compared to 5% clinoptilolite treatment (Table 4).

Dry weight

***Festuca rubra*:** There was no significant effect of both the sand or soil amendments on dry weight yield after 33 days of sowing, (Table 1). The analysis of variance showed a significant interaction between the sand and soil amendments on dry weight of grass ($p<0.05$). However, there was a significant effect of addition of sand ($p<0.001$) and the soil amendments ($p<0.01$) on grass dry weight yield after 51 days of sowing. The soil containing 50% sand significantly produced less dry matter than 0 and 25% sand treatments. This could be due to the fact that soil containing high proportion of sand did not hold plant nutrients sufficient for normal grass growth.

The data also showed that the soil amended with 10% moler accumulated the highest dry weight which was significantly different from 5% moler treatment and all the clinoptilolite treatments (Table 3).

***Lolium perenne*:** The sand treatments were highly significant fir their effect on grass dry weight yield after 28 days of sowing ($p<0.01$). However, the growth of grass was not significantly affected by the various soil amendments and their interaction with sand (Table 4). The lowest dry weight was achieved with the application of 50% sand to the mixture. Furthermore, the sand and the

soil amendments were highly significant for their effect on the second dry weight measurement; ($p<0.001$) but there was no significant effect of their interaction.

The difference in grass dry weight after 44 days of sowing indicated that increasing the proportion of sand in the growing mixture decreased the mean dry weight (Fig. 4). The impact of addition of soil amendments to the growing mixture on the dry weight differed according to the type of different soil amendments used. All the moler treatments produced significantly higher dry weight as compared to the clinoptilolite treatments (Table 4).

DISCUSSION

Normally the use of improved growing media results better plant growth and high crop production. In the present study, the addition of increasing proportion of sand to the growing media showed negative effect on the fresh and dry weight of turf grass cultivars. The increasing proportion of sand to the growing media caused significantly low fresh and dry weigh yield than the low doses of sand to the mixture. This could be attributed to the low nutrient retention capacity of the growing media, excess leaching of essential plant nutrients such as nitrogen N (Brauen, 1996; Bigelow *et al*., 2001a) or to the poor water retention capacity of the growing media (Huang and Petrovic, 1994).

Overall, the addition of clinoptilolite to the growing media appeared to give better germination when compared to the moler soil amendment. A number of factors affect germination such as moisture, aeration and temperature. It is possible that clinoptilolite addition compared to moler increases germination and establishment due to the high soil moisture availability (Ferguson *et al*., 1986) or protects seedlings from the effect of the ammonium toxicity (Leggo, 2000). However, it was observed that in the presence of clinoptilolite each grass specie performed differently with respect to seed germination (Al Gahtany, 2001).

In the present study, the growth of both the turf grass species, i.e., *Festuca rubra* and *Lolium perenne*, was not affected by the different soil amendments at the first harvest but the response was positive at the second harvest. Soil amendments such as clinoptilolite are known to produce plants with dry mass similar to plants receiving soluble fertilizer (Carlino *et al*., 1998). However, the effect of soil amendments occurred in both species at the later growth stage, which might be attributed to the retention and slow release of nutrients until plant needs them (Williams and Nelson, 1997).

In general, the growth response of grass species was positive to the moler rather than the clinoptilolite soil treatments. Similarly, the creeping bentgrass responded differently to several inorganic soil amendments in sand with regard to its establishment and growth (Bigelow *et al*., 2001b). Inorganic soil amendments differ in their physical and chemical properties like CEC, pH and mineral content (Richardson *et al*., 1999). The difference in fresh and dry weight in the presence of calcined clay may be attributed to the difference in water retention, exchangeable cations and to the reduced leaching of essential nutrients (McCoy and Stehouwer, 1998; Qian *et al*., 2001). On the other hand, calcined clay is effective in increasing air porosity and permeability which may be reflective to plant growth (Waddington *et al*., 1992).

Also, the brick grit seems to play the role of soil amendment in 0% sand treatment. Because, the growth of turf grass was not affected without soil amendments, which could implicate that brick grit could partly substitute them.

CONCLUSION

The germination was significantly better with the application of clinoptilolite than moler for both the turf grass species i.e., *Festuca rubra* and *Lolium perenne*. The fresh and dry weight of turf grass species decreased with the increasing proportion of sand in the growing media ($p<0.001$). Overall, the addition of moler to the growing mixture provided better growth for both the turf grass species i.e., *Festuca rubra* and *Lolium perenne*. Further studies are required for detailed investigation on the physical and chemical role of different soil amendments in the growing mixture to obtain normal plant establishment in landscape and play grounds under arid climatic conditions. Also, focus is required on the precise interaction of soil amendments with the sand and surrounding soil components. It is further essential to develop an experimental program that will find correlation between germination, growth and properties of soil amendments due to their differential impact on the physiology of turfgrass species.

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