INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Turfgrass response to traffic and mowing

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Traffic in relation to effects, prevention and suggestions

In Italy there are more than 8.500 soccer pitches recognized by the Italian Football Federation (FIGC), but most of them are in very bad conditions. This situation is due to mistakes during construction, poor management or wrong species/cultivar selection. Among these factors, the latter is considered the most important as it affects the quality of turfgrass from the beginning and throughout the entire life of the turfgrass.

For athletic fields, especially for soccer pitches, the selection of species and cultivars should be based primarily on traffic tolerance. The traffic causes two major problems to the turf: 1. Wearing injury (the effect of concentrated traffic that consisted on direct pressure or tearing actions on the turf that tends to destroy the leaves, stems and crowns of plants); 2. Soil compaction (traffic applies a pressure to the soil particles, which brings them together and puts them more closely).

Table 1. Water infiltration rate with double ring method (mm/h) of 10 soccer pitches in northern Italy.

pitch	corner	penalty area
Vlacovich (PD)	28	4
S.ignazio (PD)	12	6
Voltabarozzo (PD)	44	36
Marost. Vallonara (VI)	276	0,5
Legnaro (PD)	24	20
Baracca (VI)	20	0,5
Marost. Capo. (VI)	240	46
Longarone (BL)*	//	//
S.Stino di liv. (VE)	7	4
La Salute (VE)	16	58
mean	74,1	19,4

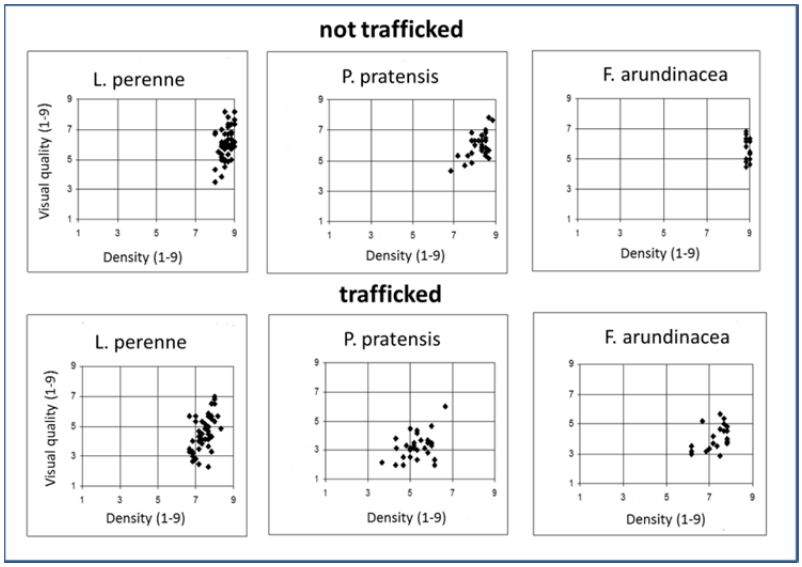
Tento projekt je spolufinancován z Evropského sociálního fondu a státního rozpočtu České republiky

The wear tolerance of a turf depends on species and cultivars characteristics such as: shoot density, root system, recuperative potential, lignin content etc.; on environmental conditions (light intensity, temperatures etc.); and on intensity of cultural practices, and overall on intensity and type of traffic. As a consequence of compaction soil structure and pore spaces are altered causing several negative effects on turfgrass including: poor water infiltration, slow drainage and oxygen deficit in the rootzone.

Compaction is strongly related to soil water content and particle size. Generally, wet and saturated soil compacts more than dry soils, clay and loamy soils respond much more to the pressure than sandy soils. To maintain healthy turf under heavy traffic a good prevention is essential. Deep and infrequent irrigation and alternate traffic pattern are the two major solutions for preventing compaction. A study conducted on 10 soccer pitches in Veneto region (Italy) demonstrated the poor attention given to the substrate used for the rootzone of which high content of fine particles are present. Only one pitch had a particle size distribution close to the USGA specification (no more than 10% of very fine sand, silt and clay particles), the remaining showed a substrate with very high level of clay or silt, thus promoting the compaction process resulting in decrease of water infiltration rate (table 1). The species used for establishing these turf surfaces were *Lolium perenne* and *Poa pratensis,* which are the most used species in northern Italy for athletic fields. The former is considered a good choice for soccer pitches since it has a very high traffic tolerance, while *Poa pratensis* has a very high recuperative potential since it spreads by strong and vigorous rhizomes. In our study *Poa pratensis* appeared to be less adaptable than *Lolium perenne* to heavy traffic and especially for soccer pitches with high compaction level and low drainage capacity. The percentage of *Poa pratensis* detected in the more trafficked areas of the 10 pitches which had been studied such as the penalty area and the center circle was much lower than that of *Lolium perenne*, while in the less trafficked areas (corner and lateral side) both species reached the same percentage. Another species that provides an acceptable playing surface in transition zone environment is *Festuca arundinacea*, a bunch-type grass with short determinate rhizomes and course leaf texture. This species is much less used than the previous ones for soccer pitches due to the poor low mowing tolerance and recuperative potential under severe wear.

Species selection is very important to determine the success of sport turf areas, however, the choice of cultivar should be highly considered as well. The results of a 3-year field study conducted at the Agricultural Experimental Farm of Padova University, revealed a different response to local environmental conditions and simulated soccer traffic of 20 cultivars of *F. arundinacea*, 49 of *L. perenne*, and 32 of *P. pratensis*. The choice of cultivar appears to be more important for *Poa pratensis* than for *Lolium perenne* or *Festuca arundinacea*. In fact, significantly higher differences in turf quality and density were observed among *Poa pratensis* cultivars under both traffic and non-traffic conditions. On the average, the traffic tolerance of *Poa pratensis* was much lower than that of *Lolium perenne* and *Festuca arundinacea* (Fig. 1). The less traffic tolerance of *Poa pratensis* could be related to a different root system. *Poa pratensis* is characterized by a very shallow root system, almost 60% of total roots length is located in the first 3 cm od depth, while the root systems of *Festuca arundiancea* and *Lolium perenne* are more uniformly distributed through the soil profile. Moreover, the roots of *Poa pratensis* are less thicker than the *Lolium perenne* and especially than *Festuca arundinacea* one. We believe that these differences in the root system are reasonable explanation of the lower wear tolerance of *Poa pratensis* in comparison with *Lolium*

Fig. 1. Variation in turf quality and density among *Lolium perenne*, *Poa pratensis* and *Festuca arundincea* cvs under traffic and non-traffic conditions.



perenne and *Festuca arundinacea*. A highly dense fine-root system at a shallow soil depth is more easily injured by cleats pressure.

The response of species and cultivars is strongly related to local conditions and construction system used. The most popular construction system for soccer pitches in northern Italy is the slit drainage. It consists on a series of narrow tranches (slits) cut into a natural soil and filled with drainage medium such as gravel or course sand. Slits are cut perpendicularly to the surface slope to intercept water, then slits transmit the water to the main underground pipe-system drainage (Fig. 3). The natural soil and slits are normally covered with 5-7 cm of river sand or lapillus.

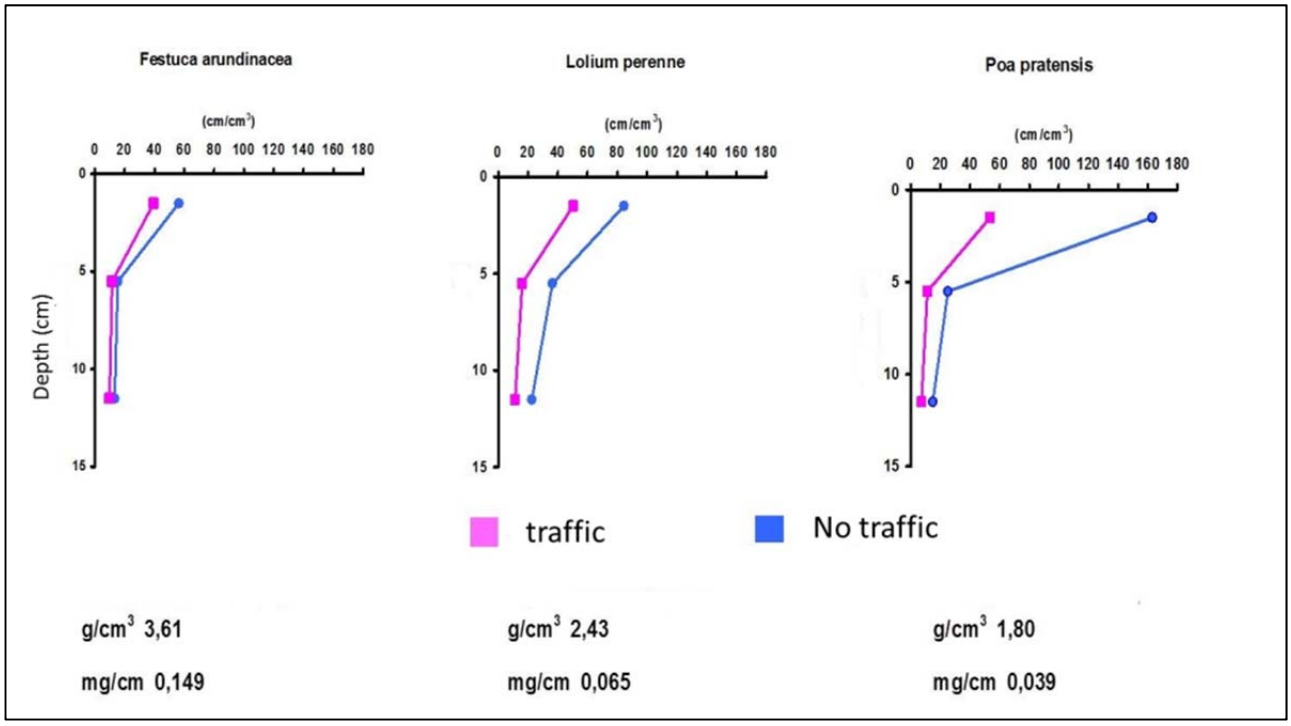


Fig. 2. Root lenght density (cm/cm^3) and specific root weight (mg/cm) of *Festuca arundinacea*, *Poa pratensis* and *Lolim perenne*. Data points are the average of three cultivars grown in a silty loam soil under traffic and non-traffic conditions.

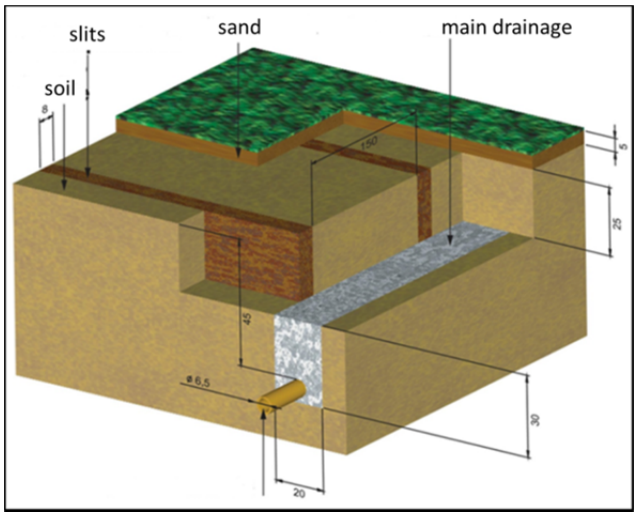


Fig. 3. Cross-section of slit drainage system with sand topsoil (5 cm).

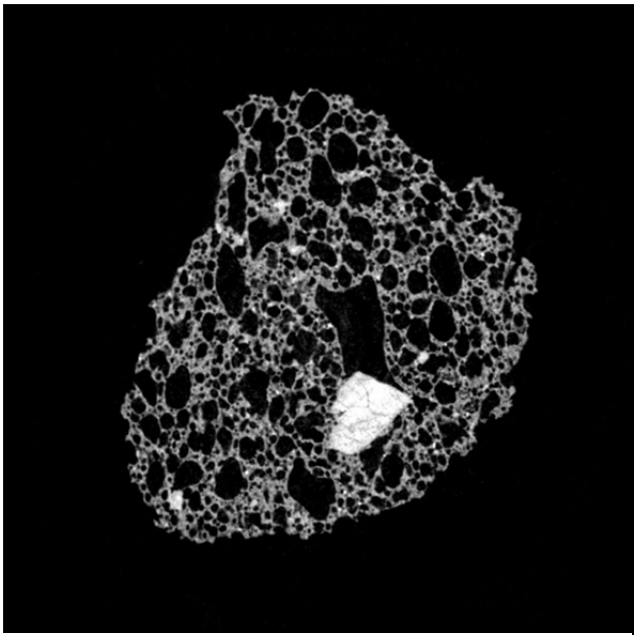


Fig. 4. Enlarged photo of volcanic particle, detail of inside channels and micro porosity.

Tento projekt je spolufinancován z Evropského sociálního fondu a státního rozpočtu České republiky

In comparison with sand based system, this form of construction has many advantages. Water evacuation is independent of the percolation characteristics of the soil in which it is established, the natural soil provides good conditions for plant growth, and it is cheaper than most of the other construction systems and especially the sand-based systems that required a complete replacement of the natural soil. Our studies demonstrated that all the three species above-mentioned perform well in this form of construction, even better than in the sand based system. The use of lapillus as topsoil ensures good growing conditions for plants. Lapillus are porous volcanic particles with high water retention capacity. However, under intense traffic, these particles tend to be shattered resulting in the increase of compaction and a loss of drainage capacity (Fig. 4), thereby, coming up to the conclusion that the use of river sand as layer on the top of the trenches is preferred over lapillus, even if a higher intensive management during establishment is required.

General considerations on mowing height and frequency

Mowing is considered the most fundamental practice in turfgrass culture. It is a destructive practice consisting on the repetitive removal of the top of leaf blades. This cultural practice strongly influences the physiological processes and conditions of plant growth. Turf species are able to survive to continuous mowing because leaf growth occurs from the base of the plant (crown). Mowing is a complex practice involving both the height and the frequency which affect the overall physiological and developmental conditions of turfgrass plants. The removal of leaf blades reduces photosynthesis and consequently food reserves accumulation. Defoliation stimulates shoot growth and tillering at the same time damaging root growth. When food reserves are limited, carbohydrates are utilized mainly by shoots which consequently gives little energy for roots. It is evident that lowering the mowing height reduces the root system and makes plants less vigorous. However, the height of mowing depends on the species used as each species has an optimum mowing height mainly resulting from morphological characteristics. Stoloniferous and rhizomatous species, and in general species with prostrate growth, are more tolerant to close mowing.

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Turfgrass should be mowed frequently enough to remove no more than 1/3 of the leaf tissues at each mowing. This is necessary to avoid excessive leaf removal, which puts the plant in a very stressed condition. However, following this rule, mowing frequency will be determined by the plant growth rate. In temperate zones, mowing frequency is generally high during spring and autumn, but decreases in summer and it stops during winter. It is not very clear the effect of intense mowing management on the variation of food reserves over seasons. We have studied for one year the dynamic of water soluble carbohydrate accumulation in Safari *Festuca arundinacea* mowed following the 1/3 rule at 80 and 60 mm and fertilized with 200 and 100 kg h^{-1} of N. On the average of the two mowing heights and nitrogen fertilizations, 'Safari' was mowed 35 times during the year. The results showed significant seasonal variations on carbohydrates content, while no differences were detected between mowing height or N fertilization rates. Soluble carbohydrates dramatically decreased in spring and autumn when the growth rate and consequently the mowing frequency reached the highest levels. Then we can say that during optimum growing conditions a continuous and regular mowing stimulates plant growth and does not allow plants to store reserves making the turfgrass very sensitive to environmental stresses.

Effect of mowing height on species succession

Since each turf species has an optimum mowing height, namely the height where species performs best, the botanical composition of turf mixtures can be strongly affected by mowing practice. When turf species are maintained below the optimum mowing height their competitive ability can be seriously reduced. *Festuca arundinacea* is the most used species in northern Italy, however its use is limited due to the poor tolerance to low mowing heights. In order to increase the use of this low-maintenance species, a plot trial was conducted for two years at Padova University to study turf quality and botanical composition of four mixtures composed of *Festuca arundinacea* and *Poa pratensis.* The mixtures included four cultivars of *Festuca arundinacea*: Lucky Selen, Rhambler srp Traverse srp and Lexington, all mixed with the same cultivar of *Pa pratensis*, named NuBlue Plus. The mixtures were compared under three different mowing heights: 20, 32 and 62 mm. The results displayed higher quality of mixtures including Rhambler srp and Traverse srp which showed very high density and finer texture than Lucky Selen and Lexington. The two mixtures with

Rhambler srp and Traverse srp demonstrated also a high suitability to be mixed with kentucky bluegrass even under low mowing height. The percentage of NuBlue plus in the mixture after two years of experimentation was about 20% lower in the Rhambler srp and Traverse srp than in the Lucky Selen and Lexington (Fig. 5). This indicates a high potential of these cultivars to be used in mixture with *Poa pratensis* for establishing low-mowing turfgrasses.

Fig. 5. Seasonal variation of the percentage of *P. pratensis* in four mixtures of *F. arundinacea* and *P. pratensis*. Average of 3 mowing heights: 20, 32 and 62 mm.