‘L-93’ Creeping Bentgrass Research Update
ESTABLISHMENT

Sand root-zones are predominantly used when constructing putting greens. Sand-based root-zones offer many advantages, such as rapid water movement through the soil profile, resists compaction under heavy traffic, and maintains good soil aeration to allow for root growth; however, water and nutrient retention are poor in sand-based root-zones. This is especially problematic during establishment of turfgrasses when water and nutrient availability are crucial for successful establishment. Therefore, the focus of this L-93 research update is to shed light on how amending a sand-based root-zone with organic or inorganic amendments impact L-93 creeping bentgrass establishment.

Seeded L-93 at 12 days

Summary

Organic vs. Inorganic Amendments

- In North Carolina, adding 10% sphagnum peat moss (organic amendment) consistently showed faster L-93 germination rates compared to inorganic amendments.
- In South Carolina, amending a sand-based root-zone with sphagnum peat took 6 months to achieve 95% L-93 ground coverage compared to 9 months using inorganic amendments.
- In New Jersey, for best L-93 establishment, amending a sand-based soil with clinoptilolite (inorganic) resulted in fastest establishment; however, sphagnum peat and reed sedge amendments showed quickest green-up and best turfgrass quality one-year after seeding.

Amendment Selection Effect on Ammonium Nitrogen Leaching

- Ecolite (inorganic), Profile (inorganic), and sphagnum peat (organic) amendments reduced ammonium nitrogen leaching compared to two inorganic amendments, isolite and greenschoice. However, all amendments significantly reduced leaching compared to an unamended sand soil profile.
- Increasing the incorporation depth of inorganic amendments reduces ammonium nitrogen leaching.
- Increasing amendment mixtures to 20% by volume does not reduce ammonium nitrogen leaching greater than a 10% by volume mixture.

Sand particle size

- L-93 establishment, density, and spring green-up were greatest using medium-fine sand. On the other hand, coarse sand resulted in slow establishment, poor density, and slow spring green-up.

Which is the best type of amendment when establishing L-93 creeping bentgrass: Organic or Inorganic amendments?

When constructing a new golf course or renovating putting greens, fast establishment is vital because slow establishment may result in lost revenues due to postponing the opening of a golf course. Due to this, there is a lot of interest in determining if adding various types of organic and/or inorganic amendments to a sand-based root-zone will increase turfgrass establishment.

Organic amendments promote soil microbial activity, but degrade over time, while inorganic amendments are not subject to degradation, thereby, in theory, they provide more long-term benefits compared to organic amendments. However, inorganic amendments are costly. For example, when constructing 19 putting greens, using 85:15 sand/peat mix would cost ~$32,000, while substituting peat for an inorganic amendment would cost ~$200,000 (Moore, 1999). For more information regarding inorganic amendments, refer to Table 1.

Researchers at North Carolina State University conducted greenhouse studies on L-93 creeping bentgrass maintained at 0.5 inches (Bigelow et al, 1999). Treatments included an organic amendment, sphagnum peat moss (10% volume) and inorganic amendments, ecolite (10%), sand-aid (40lb/1000ft^2), terrasorb gel (0.2oz/1000ft^2), isolite (10%), greenschoice (10%), Profile (10%), and sand-aid (80lb/1000ft^2 incorporated in the top 3 inches). An unamended 100% sand root-zone was included as a control. Except for sand-aid at the 80lb/1000ft^2 rate, all other treatments were fully incorporated into the entire soil profile.

Using 10% (by volume) peat moss showed greatest shoot and root biomass at the end of the study. Specifically, L-93 root and shoot mass was 3 and 4 times greater, respectively, when amended with 10% peat moss compared to all other inorganic amendment treatments. Nine days after seeding, more than 50 L-93 seedlings emerged when the sand was amended with either peat, ecolite, sand-aid (40lb/1000ft^2), or isolite. Without amendments (100% sand), <10 L-93 seedlings emerged nine days after seeding.

Table 1. Information regarding various types of inorganic root-zone amendments

Class	Examples	Benefit	Disadvantage
Porous ceramic clay	Greenschoice/Profile	Effective at retaining potassium and ammonium, does not contain weed seed	May hold water too tightly: The heating process used to make material, may lower nutrient retention
Calcined diatomaceous earth	Isolite/Axis	Increases water retention and some nutrient retention	Long-term stability is not fully understood
Zeolites	Ecolite/Clinoptilolite	Have strongest nutrient absorbing properties	May accumulate excessive sodium
Granular sea kelp/ starch-based hydrogels	Sand-aid	Improve water retention and enhance turf establishment in sand based root zones, does not contain weed seed.	Short-lived amendment

In a field study at N.C. State, researchers evaluated ecolite, greenschoice, Profile, sphagnum peat moss, and unamended sand when establishing a L-93 creeping bentgrass putting green (Bigelow et al., 2001). All amendments were mixed into the sand profile by 10% volume. Fastest L-93 establishment resulted in amending the soil with peat, followed by ecolite and profile, which responded similarly. Greenschoice showed poor establishment as it was similar to using unamended sand on several rating dates. Amendment type had little effect on root development.

In another study, researchers at Rutgers University determined the effects of adding various organic and inorganic amendments to sand-based soil profiles on L-93 creeping bentgrass putting green establishment (Murphy et al., 2005).

Organic and inorganic amendment included (volume based mixtures):

- 1:0 sand/no amendment
- 39:1 sand/loam
- 19:1 sand/loam
- 4:1 sand/loam
- 19:1 sand/sphagnum peat
- 9:1 sand/sphagnum peat
- 4:1 sand/sphagnum peat
- 19:1 sand/reed sedge
- 9:1 sand/reed sedge
- 9:1 sand/porous ceramic clay
- 9:1 sand/clinoptilolite

ESTABLISHMENT RESULTS

Sixty days after seeding, soil amended with clinoptilolite showed fastest L-93 establishment compared to other soil amendments (Table 2). The clinoptilolite amendment has ammonium and potassium on exchange sites. This is important because the nitrogen source used in this study was in the ammonium form. Therefore, compared to other amendments, clinoptilolite had more ammonium nitrogen nutrient holding potential, which presumably resulted in fastest establishment. Regarding turf cover, density, and quality, clinoptilolite had highest ratings, while unamended sand, 39:1 sand/loam, and 19:1 sand/sphagnum mixtures showed consistently lower ratings than other treatments. It should be noted that as loam and sphagnum peat amendment rates increased, cover, quality, and density ratings also increased.

Table 2. The number of days it took L-93 creeping bentgrass to reach an acceptable establishment rating following seeding.

	Days to an acceptable establishment rating following seeding†
9:1 sand/clinoptilolite	17
4:1 sand/loam	20
4:1 sand/sphagnum peat	20
9:1sand/reed sedge	24
9:1 sand/porous ceramic clay	24
9:1 sand/sphagnum peat	24
19:1 sand/loam	28
39:1 sand/loam	34
19:1 sand/sphagnum peat	34
19:1 sand/reed sedge	34
1:0 sand/no amendment	41

†Acceptable establishment was deemed when a plot could withstand mowing.

1-YEAR FOLLOWING ESTABLISHMENT

L-93 response to soil amendment one-year after seeding was very different than the establishment year data. For example, one-year after seeding, plots amended with clinoptilolite showed slowest green-up and lower quality scores compared to other soil amendment treatments. Treatments that resulted in quickest green-up and best turfgrass quality were 4:1 sand/sphagnum and 9:1 sand/reed sedge treatments. The results are in direct contradiction to the establishment year data. So, why would clinoptilolite show positive results during L-93 establishment, yet poor results one-year after establishment? One explanation is due to water availability. The following year after establishment, irrigation was withheld from plots until the middle of May. This is important to note because clinoptilolite has low water holding retention, but greater nutrient holding ability, while sphagnum peat and reed sedge has greater water holding retention. Therefore, as irrigation was light and frequent during initial establishment, the nutrient holding ability of clinoptilolite was an asset; however, when irrigation was more limited following establishment, water retention properties of reed sedge and sphagnum apparently became an asset to the plant.

Researchers at Clemson University (Waltz and McCarty, 2005) investigated how effective different soil amendments were when establishing a L-93 creeping bentgrass putting green and determined the long-term effects (>3 years) of the selected amendments. A sand-based soil was amended with 15% (by volume) sphagnum peat, calcined clay, or diatomaceous clay. An unamended, 100% sandy soil was used as a control.

ESTABLISHMENT Plots amended with sphagnum peat showed 95% ground coverage within 6 months of seeding, while inorganic amendments took 9 months to reach a similar level of coverage.

LONG-TERM EFFECTS Once all plots were established (24 months), all amendments provided acceptable color; however, sphagnum peat and diatomaceous earth had slightly higher color ratings than calcined clay and the unamended plots. No differences were noted regarding bulk density 42 months after seeding. Bulk density is an important soil measurement and potential indicator of plant health because root elongation and water movement into the soil profile can be restricted when bulk density values exceed 1.7 mg m^{-3}. Bulk density 42 months after seeding L-93 ranged from 1.4 to 1.6 mg m^{-3}, therefore, plant health should not be adversely affected since values were in the acceptable range for all treatments. The sphagnum peat amendment provided ~22% lower surface soil strength values compared to other amendments. This data is an indication of surface firmness. A firmer surface leads to more difficult playing conditions, therefore, depending on the golf course; this may or may not be a desired result.

Take-home message: Overall, amending a sandy soil with sphagnum peat leads to faster L-93 putting green establishment compared to inorganic amendments. However, once L-93 was established, acceptable quality and color was achieved regardless of amendment.

Bigelow, C.A., D.C. Bowman, and D.K. Cassel. 1999. Germination and establishment with root-zone amendments. Golf Course Management 67(4):62-65.

Bigelow, C.A., D.C. Bowman, D.K. Cassel, and T.W. Ruffy, Jr. 2001. Creeping bentgrass response to inorganic soil amendments and mechanically induced subsurface drainage and aeration. Crop Sci. 41:797-805.

Moore, J.F. 1999. Building and maintaining the truly affordable golf course. USGA Green Section Record. 37(5):10-15.

Murphy, J.A., H. Samaranayake, J.A. Honig, T.J. Lawson, and S.L. Murphy. 2005. Creeping bentgrass establishment on amended-sand root zones in two microenvironments. Crop Sci. 45:1511-1520.

Waltz, F.C. Jr. and L.B. McCarty. 2005. Field evaluation of soil amendments used in rootzone mixes for golf course putting greens. International Turfgrass Society Research Journal. 10(Part 2):1150-1158.

Does adding organic or inorganic amendments reduce nitrogen leaching when establishing L-93 creeping bentgrass putting greens?

Root-zones are predominantly composed of sand for several reasons; especially quick movement of water through the soil profile. However, this rapid downward movement of water is not beneficial

during grow-in because water retention at the surface is crucial for seed germination. Another confounding factor during grow-in is that golf course superintendent's ramp up nitrogen levels as high as 10 lbs/1000ft^2 during putting green grow-in. From an environmental standpoint, a root-zone that is porous would presumably be detrimental as the high nitrogen rates applied could potentially leach into groundwater. Due to this concern, researchers at Purdue University initiated several projects investigating which amendments, organic or inorganic, minimize nitrogen leaching during the initial grow-in phase (Bigelow, 2003).

First, the researchers incorporated sphagnum peat, ecolite, isolite, Profile, or greenschoice (20% by volume) into a sand-based root-zone. Nitrogen was applied as ammonium nitrogen (NH_4^+-N). Ecolite, Profile, and sphagnum peat treatments resulted in less ammonium nitrogen leaching compared to isolite and greenschoice. However, all amendments significantly reduced leaching compared to an unamended soil profile.

The authors then investigated the effect of increasing Profile and ecolite incorporation rates on nitrogen leaching. The authors noted that increasing amendment incorporation from 5% to 20% by volume led to significantly less ammonium nitrogen leaching; however, few differences were noted between the 10% and 20% volume mixtures. Therefore, from a cost effective standpoint, the benefits of increasing an amendment mixture over 10% by volume may be unnecessary.

The final part of this study determined the effect of incorporating ecolite and Profile (10% volume) 1, 6, or 12 inches deep. Regardless of amendment type, the deeper an amendment was incorporated into the soil profile, the amount of ammonium nitrogen leaching was significantly reduced.

Take-home message: Mixing amendments, either organic or inorganic, into a sand based profile, increasing the amount of amendments in a sand-based profile up to 10% volume, and incorporating amendments as deep into the soil profile as possible are all strategies to reduce ammonium nitrogen leaching during the grow-in phase of L-93 creeping bentgrass.

Bigelow, C.A. 2003. Inorganic soil amendments limit nitrogen leaching in newly constructed sand-based putting green rooting mixtures. USGA Turfgrass and Environmental Research Online 2(24):1-7.

Does sand particle size influence L-93 establishment?

Researchers at Rutgers University determined if using different sand particle sizes (root-zone physical properties) effect L-93 creeping bentgrass establishment (Murphy et al., 2001). Sand root zone materials selected were coarse (7, 8, or 12 inch depth), coarse-medium (9 or 12 inch depth), medium (10 or 12 inch depth), or medium-fine (12 inch depth).

At the 12 inch soil profile depth, establishment rate was greatest using medium-fine sand compared to the coarse sand. 84 days after seeding, the medium-fine sand root-zone provided greatest L-93 density, meanwhile, the coarse sand treatments showed poorest density. This is likely due to greater water holding capacity of the medium-fine sand.

Regardless of sand particle size, reducing the depth of the sand profile resulted in better L-93 establishment and cover. This is likely attributed to greater water being available near the surface for the newly emerging seedlings. Regarding spring green-up, medium fine sands provided quicker green-up, while coarse sand showed poorest spring green-up. 1-year after seeding, coarse sand showed poorest turfgrass quality, while medium-fine sand showed best turfgrass quality. However, reducing the depth of the coarse sand from 12 inches to 7 inches improved turfgrass quality by >1 rating unit.

Take-home message: When considering a sand source for establishing L-93 creeping bentgrass, medium-fine sand enhanced L-93 establishment, density, and spring green-up compared to coarse sand.

Murphy, J.A., J.A., Honig, J.A., H. Samaranayake, T.J. Lawson, and S.L. Murphy. 2001. Creeping bentgrass establishment on root zones varying in sand sizes. International Turfgrass Society Research Journal. 9(Part 2):573-579.