

Appendix A

CHARLESTON VEGETATED GREEN ROOF MAINTENANCE MANUAL

1. Introduction

This reference guide is intended to be a practical manual to properly maintain a vegetated green roof. As with any maintenance program, there are both preventive and reactive programs. This manual outlines a preventive program that minimizes cost and time in favor of the reactive approach.

2. Roof Maintenance Safety Procedures

It is the responsibility of the building owner/homeowner/maintenance provider/etc. to ensure that precautionary measures are taken when maintaining the vegetated green roof. Please refer to www.OSHA.gov to see the most up-to-date roof safety regulations.

3. General Roof Housekeeping

Drain Cleanout

The primary cause of water pooling and flooding is clogged drains and gutters. We recommend cleaning out all gutters and drains at least once a month.

Loose flashing

During the normal maintenance routine, the flashings on the roof should be checked and repaired if needed. This simple step could prevent the need for re-roofing or repairing a leak.

Fall/Winter Clean-up (optional)

Once the vegetated green roof plants mature, most varieties will flower abundantly. This provides beautiful colors from the spring through the fall, but may leave unsightly flower stalks in the winter. These stalks can be removed carefully with a string trimmer.

4. Nutrients and Supplements

Vegetated green roof plants use the rain and pollutants contained therein as a food source. However, before the vegetated green roof is fully established, the plants will need additional nutrition. Supplying the proper nutrition during the establishment period will enable the plants to grow more rapidly and fill in the vegetated green roof area. This slows weed growth, prevents wind and rain erosion and improves roof appearance.

Fertilizers

Vegetated green roof plants do not require much fertilizer, but throughout the establishment period they will need more nutrients than the rain can provide. A balanced slow release fertilizer that releases over a period of 3-12 months is best. Osmocote or Nutricote are examples of commercially available slow release fertilizers. Initially a 10-10-10 is good at supporting top growth, root growth and flowering (14-14-14 or similar can also be used). In the second and later years as the plants fill in and growth slows, the fertilizer ratio should be changed to more nitrogen(ex. 18-6-12) but still be of a slow release variety. In addition to promoting growth, fertilizers also keep the plant healthy

and more resistant to disease. If the vegetated green roof is to be used for aesthetic reasons, the fertilizer will keep the plants looking their best.

Biologicals

Most roof soils are comprised of a lightweight aggregate that is heated to very high temperatures (resulting in sterilization) and a small percentage of sterilized compost. Sterilization may cause the soil to be deficient in biologicals. Biological supplements such as compost teas, worm castings and worm casting teas (ex. VermaPlex), biological nutrients (OMRI Nutricast) and mycorrhizal injections (Mycorrhizal Application, Inc.) may be required in some instances. If the plants are not growing after they been fertilized and treated with fungicide, biologicals may be worth consideration.

5. Disease Prevention and Treatments

Vegetated green roof plants are considered resistant to most diseases and pests problems; however, on occasion a disease or insect problem may arise. Sedums and ice plants are less susceptible to fungus infection than on-the-ground plants. However, fungus issues can still develop. There are three main funguses that cause vegetated green roof plant damage: 1) *Pythium*, seen as damping off and root rot; 2) *Rhizoctonia*, also primarily root rot; and 3) *Fusarium* seen as leaf wilt or spots. Prior to treatment, a professional should be consulted to properly diagnosis the issue. Without proper identification of the diseases and/or insect, one cannot properly treat the issue at hand. Our goal is to limit problems by utilizing a preventive maintenance program.

Preventative Treatments

There are several fungicides which can help protect your vegetated green roof plants: *Rhapsody* or *CEASE*, is an organic fungicide and it is available from most agricultural chemical suppliers. *Chorothalonil* is sold as Ortho Garden Disease Control, Daconil, and included in fungicides such as Initiate 720. They are available in most garden centers. Chemical fungicides containing the following ingredients will also help control disease: Thiophanate Methyl, PCNB, Iprodione, Azoxystrobin, Fludioxonil and Flutolanil. We strongly recommend consulting a professional horticulturist or landscaping supply store to help identify the issue prior to purchasing or applying any fungicides. Always follow ratio and safety guidelines when applying, or hire a professional to apply.

Cure Outbreaks

A preventive maintenance program will significantly reduce the risk of disease outbreak. Such outbreaks are usually not detected until the disease has progressed to a noticeable level. This usually happens after a period of several weeks of rains or periods of drought with very high temperatures (over 90 degrees). It is best to have a professional diagnose the disease before starting a spray/drench application.

Safe Application Practices

Fungicide application, like application of insecticides and pesticides, should be done safely. Please read the entire label and follow all safety precautions.

6. Pests

Most pests are controlled by the intense conditions of a vegetated green roof micro-climate, however some pests will surface as a result of over-irrigation.

Above ground pests

Most pests will be seen during the vegetated green roof establishment period. Snails and slugs can be indicators of excess irrigation or excess rain and they will multiply in moist soil. The best solution is to decrease irrigation. The snails and slugs will die out once the irrigation or rains have become normal. In some circumstances, snail pellets may be needed.

Below ground pests

Mealy bugs, sow bugs and centipedes have been found in vegetated green roof plants. They can be treated during fungus spraying with additions of liquid seven. They rarely have a detrimental effect on the plants. If the plants aren't doing well, first check for fungus and then look at the roots of a plant. Mealy bugs show up as white areas, and sow bugs and centipedes are easily seen. A worst case scenario would require an application of liquid seven. Please note that liquid seven will kill bees so we do not recommend using while plants are flowering.

7. Weeds

Like any garden, weeds are the biggest maintenance requirement. Roofs, due to their elevated position, are less susceptible to weed infestation but they are not totally immune. Some weeds have enormous root structures and can survive in extreme conditions found on rooftops.

Prevention

Although we want to avoid treating the roof with chemicals, one method of minimizing weeds is to treat the area with a pre-emergent herbicide. Please be sure to read the label and follow instructions.

Removal

During the first year, weeds should be pulled and removed at least every 2 weeks. They are much easier to pull after a rain and before their roots get too deep. Weeds thrive in mid to late summer, and many will go to seed after only a few weeks growth. Every effort must be made to remove the weeds before they go to seed.

8. Irrigation

Poor irrigation and moisture management is the leading cause of damage to vegetated green roof plants. This is done by either ignoring irrigation during periods of extreme drought or more frequently, by over watering. Vegetated green roof plants are naturally drought tolerant, but they need periodical water to keep them healthy and growing well, especially during the first year when they are becoming established.

Different from other plants

Vegetated green roof plants differ from other plants in their photosynthesis process. Under conditions of sufficient water, they run photosynthesis in one step: they absorb carbon dioxide, water and sunlight, and give off oxygen during daylight hours. However,

during periods of water deficiency, they shift the photosynthesis process into 2 steps: 1) reaction of carbon dioxide with water and sunlight during the day, and 2) expulsion of oxygen and uptake of carbon dioxide during the night. By doing this, the stoma (breathing holes) are only open during the cooler nights, thus conserving water. The key point is that this capability still requires water but not as much as a normal plant. Another item to note is that they cannot tolerate having roots immersed in water for days at a time. Dry period are necessary for their health.

Recommended Irrigation

Proper irrigation depends on soil depth, humidity, age of the plants and temperature. For 4 inch deep soil, here's the recommendations during spring/summer/fall, and a watering is considered a rain event or you manually soaking them with water: 1) Newly planted plugs: water every other day for first week, then twice a week for next 2 weeks and then once a week for next 2 weeks. Make sure they get water at least every other week from then on to look good. 2) Established plants/sedum mats: water twice a week for first 3 weeks, then once a week for next 2 weeks. Make sure they get water about once every two weeks after that to always look good. More frequent watering will make the plants grow slightly faster but will also make them more susceptible to diseases.

Established plants can get by with water every month as a minimum, but will not look as good as those that get it at least once every couple weeks.

We can't stress enough --- OVERWATERING KILLS PLANTS!

9. Plant Fill-in and Replacement

As the vegetated green roof grows in, there will most likely be some areas where the plants die out or just don't fill in fast enough. It is important to maintain a large surface area vegetation coverage as the vegetation maintains the soil moisture content and prevents the roots from drying out. In addition, open areas allow for weeds to take over which can be invasive and take over the roof. If there are no obvious problems and the areas are small, these areas can be improved by taking cuttings off bigger plants and partially burying the cuttings in the soil of the bare areas. If a larger area needs work, the best solution is to purchase assorted pre-grown plants, and plant them in those areas. *Remember if you don't try to cover an open area, nature will do so with weeds.*

10. Summary

Year 1

- Irrigate as recommended above, utilize the temporary irrigation system for the first two months to ensure establishment. Be cognizant of rain events and do not overwater.
- For newly planted, apply slow-release fertilizer in spring and fill in plants as needed
- For newly planted, weed every month or as needed to keep them in check
- Once the plants are established, weed quarterly or as needed
- Clean debris & leaves from around modules and drains quarterly
- Replace plants as needed to maintain at least fifty (50) percent surface area at all times.

Year 2 and Beyond

- Weed quarterly or as needed to keep them in check
- Apply slow-release fertilizer in spring
- Replace and fill in plants as needed
- Clean debris & leaves from around modules and drains quarterly
- Irrigate as recommended above, except if rain occurs