A New Way of Looking at the Weather[1]

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[1] a presentation at the Sustainable Turfgrass Management in Asia 2012 conference, 14 March 2012, at Pattaya, Thailand

The weather, and specifically the temperature and the amount of sunshine, has a major influence on the growth of grass and therefore on the suitability of certain grasses for certain climates. By plotting the climatological normal weather data with temperature on the horizontal axis (x-axis) and sunshine hours on the vertical axis (y-axis), we can see which locations are similar in these parameters, and thus likely to be suitable for the same grasses, and to similar maintenance practices for grasses. Many locations in East, South, and Southeast Asia are distinguished by relatively low sunshine duration as compared with locations of similar temperature in North America, Oceania, Africa, and Europe. For additional information about the use of these charts, see www.climate.asianturfgrass.com.

Maintained turfgrass in Southeast Asia is characterized by the relatively fast growth rates of manilagrass (*Zoysia matrella*) and broadleaf carpetgrass (*Axonopus compressus*) and the prevelance of those species on established golf courses. Although hybrid bermudagrass (*Cynodon dactylon* x *C. transvaalensis*) or seashore paspalum (*Paspalum vaginatum*) are often planted on golf courses in this region, these species persist only when they receive extensive inputs.

To understand why certain grasses thrive while others struggle to survive, it is useful to consider the factors that influence growth (Table 1). Plant growth can be modeled as a function of temperature, light, water status, and nitrogen status[2]. In maintained turfgrass systems, the water and the nitrogen are controlled by the turfgrass manager, leaving the temperature and the light as uncontrollable factors.

[2] Park S. Nobel. *Physiochemical and Environmental Plant Physiology*. Academic Press, 2nd edition, 1999

What influences turfgrass growth

Factor	Controlled by Turfgrass Manager
Temperature	No
Water	Yes
Nitrogen	Yes
Light	No

Table 1: Factors that influence the growth of turfgrass and their ability to be controlled by the turfgrass manager

Temperature

Warm-season (C_4) grasses grow best in a temperature range[3] from 27 to 35°C. Cool-season (C_3) grasses grow best in a temperature range from 15 to 24°C. Warm-season grasses such as manilagrass, bermudagrass, seashore paspalum, and broadleaf carpetgrass respond similarly to temperatures within the optimum range range for warm-season grasses.

[3] These temperature ranges are general guidelines from Beard [1973]

Water

We can consider the water supply to the grass to be under the control of the turfgrass manager. The management of water supply is

controlled by drainage systems to remove excess water and with irrigation systems that can supply necessary water. Therefore, in a maintained turfgrass situation, we do not need to consider the natural supply of water as influencing the growth of the grass.

Nitrogen

We can also consider the nitrogen status of the grass to be under the control of the turfgrass manager. This is accomplished through fertilizer applications that supply a precise amount of nitrogen.

[4] sunshine hours are the measured duration of time during which direct solar irradiance exceeds 120 W m^{-2}

Light

There are substantial differences in sunshine hours[4] among locations where warm-season grasses are grown. The data in Table 2 show that many of the cities in Asia average less than 200 hours of sunshine each month, while cities such as Phoenix, Miami, Honolulu, and Atlanta – where much of the maintenance advice for warm-season grasses is generated – have more than 200 hours of sunshine each month.

City	Mean Monthly Sunshine Hours
Phoenix	323
Dubai	293
Miami	263
Honolulu	254
Chennai	231
Atlanta	228
Bangkok	220
Sydney	209
Kota Kinabalu	205
Bangalore	198
Kuala Lumpur	186
Sanya	183
Kolkata	176
Singapore	169
Shanghai	165
Osaka	163
Jeju	162
Hong Kong	154

Table 2: Monthly normal sunshine averages for a selection of world cities where warm-season grasses are often grown

Understanding and using the charts

There is an evident influence of light on turfgrass performance in Asia. We observe that bermudagrass in particular tends to struggle when the sunshine hours are less than 200 hours per month. Bermudagrass cultivars that have been selected in sunnier climates are, unless special attention is given to the grass, gradually taken over by manilagrass, seashore paspalum, and broadleaf carpetgrass when maintained under mown conditions in Southeast Asia. A variety of charts, of which Figure 1 is an example, have been developed to better visualize the influence of light and temperature on the growth of turfgrass[5] . These charts can be downloaded or viewed at www.climate.asianturfgrass.com.

[5] data plotted on these charts are from the climatological normals dataset of the World Meteorological Organization, as posted at the Hong Kong Observatory website, http://www.hko.gov.hk/

Comparison and contrast

Because these charts plot cities by their temperature and sunshine hours, the two major factors influencing photosynthesis that are uncontrolled by turfgrass managers, the location of the bubble for a city on the chart is an indication of the natural growing environment for grass during the time period shown on the chart. This can be useful by comparing and contrasting areas in which we know how

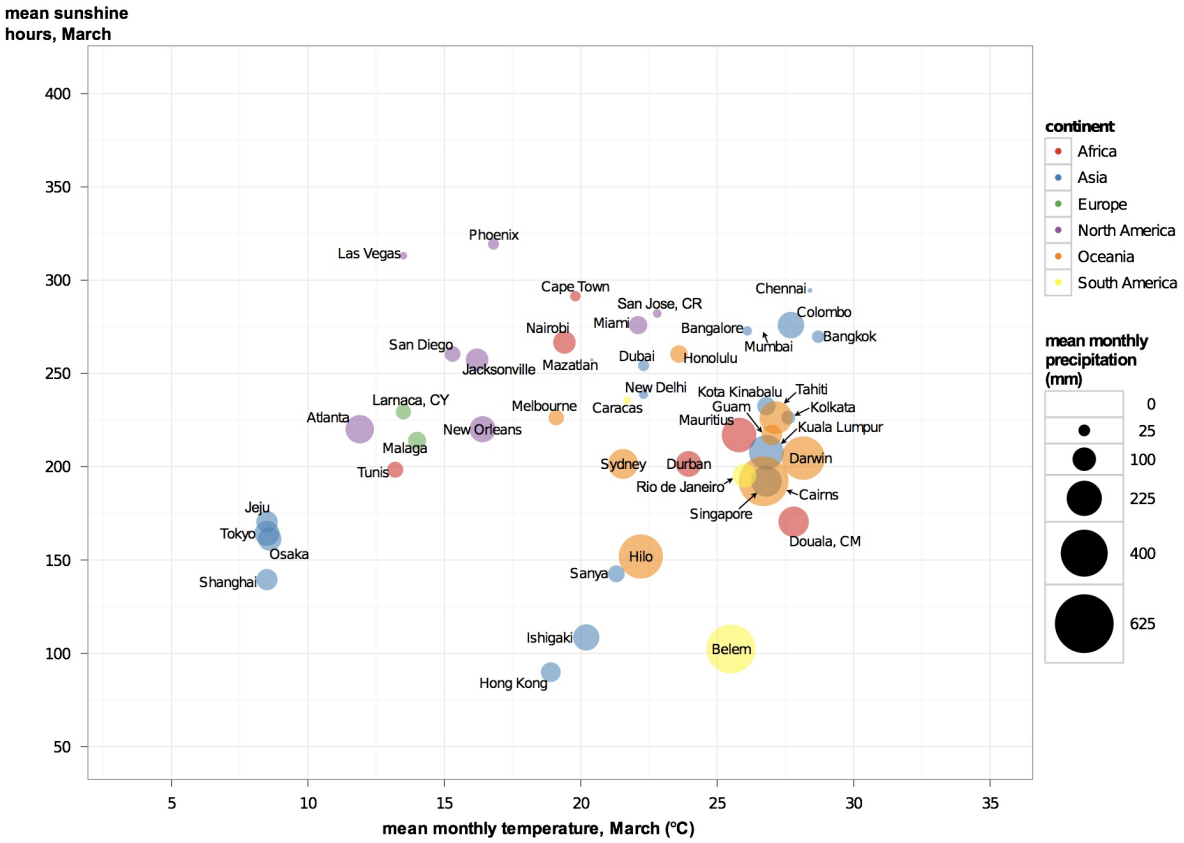

Figure 1: World cities plotted by annual climatological normal data

grass should be managed and which grasses thrive in a particular environment.

As an example of unexpected differences among nearby cities, for example, we see that Bangkok and Colombo have similar temperatures and sunshine in March (Figure 1, and we expect good growth of any warm-season grass at these cities during this month. Kuala Lumpur, less than half the distance from Bangkok as Colombo, and at which we might expect similar conditions to Bangkok, being on the same peninsula, on the same side of the Indian Ocean, and with a similar temperature during this month, has 62 hours less sunshine. That is more than five full days of sunshine that happens at Bangkok but not at Kuala Lumpur[6].

We also can note unexpected similarities. Again looking at the average for March, we observe that Miami, Dubai, and Honolulu have very similar growing conditions. One on a tropical island in the middle of the Pacific Ocean, another a city on the Arabian Peninsula, and the other a coastal city bordered by the Atlantic Ocean, but during March the growing conditions for grass are predicted to be very much the same at these three locations.

[6] the day length at Kuala Lumpur in March is 12 hours

Planning maintenance work

Warm-season grasses have the potential to grow at their most rapid rate with increasing temperatures and with increasing sunshine. Therefore, the relative location of the bubble for a location is an indication of how fast the grass can grow during the depicted time period. If a city is far to the right (indicating high temperatures) and high on the plot (indicating high sunshine), the potential growth of warm-season grass is high. Conversely, if the temperature is low, or the sunlight hours are low, the potential growth of the grass will be limited, and this is easily seen by a location on the to the left (indicating cool temperatures) or relatively low on the chart (indicating low sunshine). With a little study, these charts can be used to give a good indication of when certain maintenance practices are most likely to be successful at a particular location. Examples of work usually scheduled according to growth potential include:

- core aerification
- application of growth regulators
- verticutting or scarifying
- overseeding
- application of fertilizer

Choosing grass

Choosing grass species and cultivars for warm-season areas requires more than just looking at the temperature. Under conditions of regular mowing in areas that do not receive more than 200 hours of sunshine per month, it is difficult to maintain bermudagrass, and species such as manilagrass, seashore paspalum[7], and broadleaf carpetgrass should be considered as better choices.

[7] Seashore paspalum should only be used when ample water is available for irrigation during the dry season

References

J.B. Beard. *Turfgrass: Science and culture*. Prentice-Hall, Englewood Cliffs, NJ, 1973.

Park S. Nobel. *Physiochemical and Environmental Plant Physiology*. Academic Press, 2nd edition, 1999.