Summer bentgrass decline and use of biostimulants and PGR's

The decline in turf quality and root growth of creeping bentgrass is a major concern in managing bentgrass greens in warm climatic and transitional regions. Rutgers University researchers Bingru Huang and Yan Xu have investigated whether foliar application of trinexapac-ethyl and two biostimulants containing seaweed extracts would alleviate summer decline.

Creeping bentgrass (*Agrostis stolonifera* L.) grows vigorously during spring and autumn, but turf quality often declines during summer months, referred to as summer bentgrass decline syndrome (Carrow, 1996).

Summer bentgrass decline is a major concern of superintendents growing creeping bentgrass on putting greens, especially in warm climatic and transitional regions. Heat stress is a primary factor leading to the decline in turf quality and physiological activities of creeping bentgrass (Huang, 2001). Summer bentgrass decline is characterised by a thinning of the turf canopy, leaf senescence and root dieback. Root dieback inhibits the production of cytokinins, a class of plant hormone that are primarily produced in roots, which in turn affect shoot growth and senescence.

Management practices such as irrigation, fertilisation, mowing, pesticide use and soil cultivation are primarily used in managing stressed turf. In recent years, however, there is increasing interest in using organic compounds or natural products for promoting turfgrass health due to stringent environmental regulations and negative public perceptions of pesticides and fertilisers.

Some golf courses apply various compounds on bentgrass, hoping to improve turf growth during summer months. Incorporation of management practices such as use of natural products or plant growth regulators (PGRs) that may promote shoot and root growth would favour creeping bentgrass survival in the summer.

Summer decline is a major concern of supers growing bentgrass on greens, especially in warm climatic and transitional regions.

PGRs have been available in turfgrass management for several decades. This broad class of compounds is traditionally used in turfgrass management for suppressing seedhead formation and inhibiting vertical shoot growth to reduce mowing and control weeds in low maintenance areas, such as roadsides and golf course roughs.

Since the 1980s, many new chemicals have been developed that have improved efficacy and reduced phytotoxicity. In recent years, there has been increasing interest among superintendents in utilising PGRs for multiple purposes, such as enhancing overall turf quality, promoting a smooth and uniform playing surface and improving stress tolerance in higher maintenance areas. The use of PGRs has, therefore, become almost a standard practice in turfgrass management on golf courses.

A PGR inhibiting cell elongation, trinexapac-ethyl (Primo), has been mainly used for clipping reduction and improving general turf quality (Fagerness et al., 2002; Lickfeldt et al., 2001; McCullough et al., 2005). Recently, trinexapac-ethyl has been found to be effective in improving turf performance under unfavourable environmental conditions, such as shade (Ervin et al., 2004; Goss et al., 2002), freezing (Fagerness et al., 2002), heat tolerance (Wang et al., 2006), and combined drought and heat stress (McCann and Huang, 2007).

Some natural products can stimulate plant growth and development and are classified as plant growth promoters or collectively named biostimulants. Numerous organic products, claimed to have the functions as biostimulants, have emerged in recent years. The variety of ingredients in these products is remarkable (Karnok, 2000). Biostimulants may include carbon sources, humates, microbial suspensions or powders and hormone-containing products such as seaweed extracts. Among them, seaweed extracts are widely used in various biostimulant product formulations.

Seaweed extracts contain a large number of organic compounds such as cytokinins, auxins, amino acids, vitamins, simple and complex sugars, enzymes and proteins, as well as inorganic nutrients such as N, P, K and Fe. Seaweed extracts are rich in cytokinins and therefore their stimulating effects on turfgrass growth have been attributed mainly to high concentrations of cytokinins, which are plant hormones regulating cell division, leaf senescence and stress defence.

However, not all products may be as effective as anticipated. The effectiveness of growth promotion of biostimulants varies greatly with plant species, physiological conditions of the plants, product formulation/composition, application rate and timing. Many environmental factors and other cultural practices also influence the efficacy of

biostimulants. Therefore, superintendents may find that the effects of biostimulants are inconsistent.

Many biostimulants promise better turf quality and stress tolerance. In most cases, the primary ingredients in biostimulant products have proved beneficial to plant growth in laboratory and/or greenhouse experiments (Zhang and Schmidt, 2000). The effectiveness of PGRs and biostimulants on bentgrass summer performance under field conditions, however, is not well documented.

With the increasing use of biostimulants on creeping bentgrass putting greens, the information on whether and how the biostimulants affect creeping bentgrass summer performance would help turf managers develop more efficient summer stress management practices. This article reports results on a field study carried out in 2007 and 2008, with an aim to address the question whether foliar application of trinexapac-ethyl and two biostimulants containing seaweed extracts would alleviate decline in creeping bentgrass growth during summer.

RESEARCH METHODOLOGY

The experiment was conducted on a USGA specification putting green established with Penncross creeping bentgrass at the Hort Farm II, North Brunswick, New Jersey. The green was mowed six days per week at 4mm and clippings were removed. It was irrigated daily to replace 100 per cent evapotranspiration water loss. A 16-4-8 fertiliser was applied in April (northern hemisphere spring), June (northern hemisphere summer) and September (northern hemisphere autumn) at a rate of 122kg/ha of nitrogen in 2007 and 2008 to maintain adequate soil nutrient status. Fungicides (Spectro 90WDG, Daconil Ultrex, Pentathlon and Banner Maxx) were applied on a curative basis mainly to control dollar spot and brown patch.

The two biostimulants used were CPR and TurfVigor. CPR is a blend of natural sea plant extract, micronutrients and a surfactant agent. It contains 4 per cent N, 1 per cent K_2O, 0.53 per cent Mg, 1 per cent S, 2 per cent Fe, 0.25 per cent Mn and 0.2 per cent Zn. TurfVigor is a formulation containing 0.014 per cent patented microbial strains (*Bacillus* sp. and *Paenbacillus* sp.) along with kelp extract and macro- and micro-nutrients. This product contains 9 per cent N, 3 per cent P_2O_5, 6 per cent K_2O, 0.6 per cent Fe, 0.05 per cent Mn and 0.05 per cent Zn.

All three products – trinexapac-ethyl, CPR and TurfVigor – were applied following their respective manufacturer recommended rates:

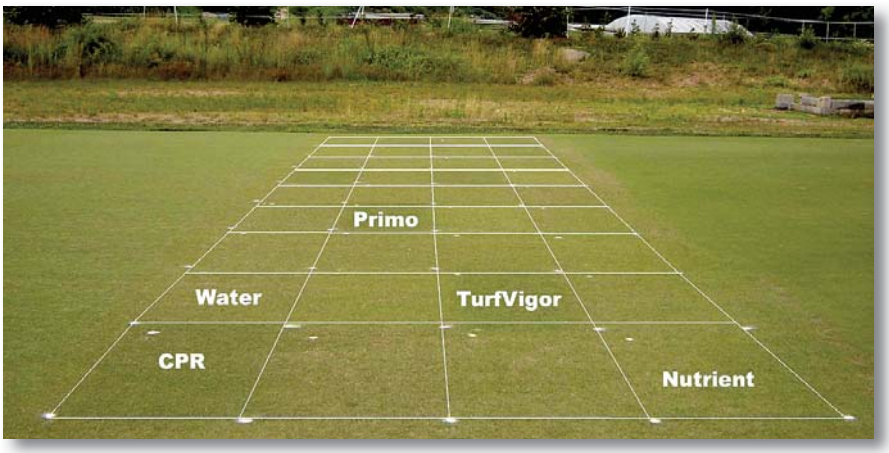
- Trinexapac-ethyl (120g ai/l emulsifiable concentrate) – 0.05kg ai/ha
- TurfVigor – 47.75l/ha; and
- CPR – 19.10l/ha.

The water volume applied for control and carry volume for TurfVigor, CPR and trinexapac-ethyl was 2 gallon per 1000 ft^2 (7.6l/92.9m^2) Water (control) treatment was also included in the experiment. Each control plot was treated with the same volume of water as the volume of trinexapac-ethyl or biostimulant solutions sprayed on treated plots. Treatments were applied using a CO_2-pressurised backpack sprayer on 23 June, 6 and 25 July, 8 and 24 Aug and 7 Sep, and on 11 and 27 June, 11 and 28 July, 13 and 27 Aug in 2008.

Shoot growth and overall turf performance of creeping bentgrass were examined by measuring turf quality, turf density, leaf chlorophyll content and canopy net photosynthetic rate. Root growth was examined by measuring total root surface area and root biomass.

EFFECTS OF TRINEXAPAC-ETHYL ON SUMMER PERFORMANCE OF CREEPING BENTGRASS

Application of trinexapac-ethyl significantly improved turf quality of creeping bentgrass from mid-August to mid-September in 2007 (see photo page 68)



Effects of trinexapac-ethyl, CPR, TurfVigor and control treatments on turf quality of creeping bentgrass in August 2007

and from early July to mid-September in 2008. The improvement in turf quality was associated with increases in green colour and turf density.

These positive effects of trinexapac-ethyl are most likely due to a combination of decreased leaf senescence and increased tillering capability. Trinexapac-ethyl has been shown to increase total chlorophyll content per unit leaf tissue and canopy density as measured through tiller counts or visual ratings (Ervin and Koski, 1998 and 2001; Fagerness and Yelverton, 2001; Stier and Rogers, 2001).

Ervin and Zhang (2007) reported increases in cytokinin content in plants treated with trinexapac-ethyl. While cytokinins are known to promote tiller formation, the higher density in trinexapac-ethyl-treated turf may be associated with the increases in cytokinin production. We also observed trinexapac-ethyl application increased canopy net photosynthetic rates on some sampling dates, suggesting trinexapac-ethyl may increase photosynthetic capacity that could favour creeping bentgrass survival under summer stress.

The effects of trinexapac-ethyl application on root growth were not consistent between 2007 and 2008. Trinexapac-ethyl-treated plots had increased root biomass on two of the six sampling dates in 2007, but such effects were not observed in 2008. Some previous studies reported increased root growth (Han et al., 1998) whereas others found no effects of trinexapac-ethyl on root biomass (Fagerness and Yelverton, 2001).

In general, effects of trinexapac-ethyl on root growth are inconclusive. It appeared that the positive impact of trinexapac-ethyl application on improving summer turf performance in creeping bentgrass could be mainly due to its effects on turf canopy, by promoting greener and denser turf.

EFFECTS OF BIOSTIMULANTS ON SUMMER PERFORMANCE OF CREEPING BENTGRASS

The two biostimulants significantly improved visual quality of creeping bentgrass putting green during the summer in both years. Leaf senescence during summer was alleviated, as manifested by suppression of chlorophyll loss and increased canopy density in plots treated with either product.

The maintenance of higher chlorophyll and more photosynthetically active leaves enabled the maintenance of higher canopy photosynthesis in creeping bentgrass treated with TurfVigor or CPR during summer months in both years. There were also some positive effects of both biostimulants on root growth of creeping bentgrass, although the effects were not consistent throughout the entire summer months (July-September) in either year.

Specifically, TurfVigor-treated plots exhibited larger root surface area on 14 Aug in 2007 and 10 Sep in 2008 and higher root biomass on 17 July and 14 Aug in 2007 and 26 Aug and 10 Sep in 2008. CPR-treated plots exhibited greater root biomass on 10 Sep in 2008.

The positive effects of seaweed extract-based biostimulants on shoot and root growth may be due to the function of various organic compounds present in the extract, particularly the relatively high levels of cytokinins. Cytokinins are known for their functions of suppressing leaf senescence and promoting tillering (Xu et al., 2009).

Zhang and Ervin (2008) recently compared the effects of seaweed-based cytokinins to a cytokinin standard (10 mM ZR) on creeping bentgrass under heat stress (35-25°C, day/night) and found that endogenous cytokinin contents increased to comparable levels for the two treatments. Therefore, application of seaweed-based biostimulants could affect the hormone status within plants. The microbial strains in TurfVigor may have some additional beneficial effects, but need further testing.

CONCLUDING REMARKS

If used properly, biostimulants and PGRs provide a promising management tool in promoting turf health and improving summer stress tolerance in creeping bentgrass. The effectiveness of products may vary, depending on environmental factors and how products are applied.

However, one must remember that plants typically grow well without additional PGRs or biostimulants in favourable environmental conditions. When turf is subjected to stressful conditions, a plant's defensive system declines. Pre-conditioning plants with PGRs or biostimulants in anticipation of stress may enhance stress tolerance and improve turf performance. The products may not perform as well if applied later when plants are already stressed.

With continued research and further understanding the mode of actions of different products, it is likely that PGRs and biostimulants, along with proper routine cultural methods, will play a vital role in maintaining high quality turfgrass.

ACKNOWLEDGEMENTS

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