

Effects of Super Absorbent Polymer on Low Temperature Stress of Plant

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Abstract—With the increasing of the application of super absorbent polymer (SAP) used on turfgrass, the characteristics of turfgrass development were significant influenced by SAP. This paper studies effects of SAP on cold resistance characteristics of turfgrass. The main results are as follow. Low temperature stress and time led to the decreasing of root activities and superoxide dismutase (SOD) activities of turfgrass as well as the increasing of the relative electrical conductivities (REC), the concentration of proline (Pro) and malondialdehyde (MDA). Increasing of root activities, SOD activities and the concentration of Pro and decreasing of MDA contents and REC were observed with SAP.

Keywords—Turfgrass; Cold resistance; Super absorbent polymer

I. INTRODUCTION

While chilling injury has a wide range impacts in the global plant production, the effect of low temperature on turfgrass is more obvious, such as yellow pot phenomenon, which has a negative influence on the ornamental value of the lawn. Simply identify cold-season turfgrass as species with higher cold resistance is not rigorous. Proper temperature for cold-season turfgrass is 15.6-23.9 °C, beyond which, the health and normal growth of turfgrass will be disrupted. Enhancing the cold resistance of turfgrass by using SAP has great significance on aspects as improving lawn quality, solving winter lawn yellowing problem and extending the green period.

SAP is a kind of high absorbent resin, which can rapidly absorb and retain water weighing hundred times of its own weight when applied to the soil. The gel formed after SAP absorbed water keeps the water from separate out and it has good water absorption and water retention ability. SAP is widely used in the industry, agriculture, medicine and other fields. The rare application of SAP on turfgrass is also lack of systematic and in-depth research [1-2].

Upon the poor resistance and heavy water-consuming conditions of turfgrass, this research explores the influence of SAP on turfgrass's cold resistance by experiments to provide theoretical basis.

II. EXPERIMENTAL MATERIALS AND METHODS

A. Experimental Materials

The tested seed is *Lolium perenne* L., the breed is Aishente No. 2, provided by Beijing Bright Turf & Forage Co., Ltd. The tested SAP named "Walt" is provided by Dongying Huaye New Material Co., Ltd. The tested soil is collected from the campus of Soochow University, and its

basic fertilities can be shown in table 1. Chemical reagents are all analytically pure.

B. Experimental Design and Methods

The healthy and plump seeds were selected and rinsed with distilled water, then wrapped with clean gauze after dried with filter paper, continuously place the seeds in 70% ethanol for 30 seconds, and then disinfected by 1% potassium permanganate solution, and rinsed by distilled water repeatedly and soaked in the sterile water for 24 hours, finally placed on a disinfected petri dish above 3 pieces of sterile filter paper to be germinated for 48 hours.

Then tested soil is divided into 2 nutritional pots, one mixed with SAP. Seeds were planted on the soil, after germinating and covered with air dried soil in 0.5 cm depth. Pots were placed in light incubator with temperature set to 20 °C and photoperiod set to 12(light)-12(night). Waters were replenished daily until lawns were formed (in 60 days). Then lawns were placed with low temperature stress under 5 °C, 0 °C, -5 °C, -10 °C for 24, 48, 72 hours with 3 replications respectively.

TABLE I. THE BASIC FERTILITIES OF THE TESTED SOILS

pH	Soil texture	Organic matter (g kg ⁻¹)	Avai.P (mg kg ⁻¹)	Avai.K (mg kg ⁻¹)
7.59	Loose sand	14.42	136.5	374.8

C. Determination of the Sample

Cell membrane permeability was measured by relative electrical conductivity method, Pro contents are measured by sulfosalicylic acid method, the root activities are measured by TTC method, the MDA contents are measured by thiobarbituric acid method, the SOD activities are measured by NBT method, soil organic matter was measured by K₂Cr₂O₇-H₂SO₄ method, the available P contents are measured by Olsen method, the available K contents are measured by flame photometry method [3-6]

D. The Data Processing

Statistical analyses were performed using the statistical software program SPSS (Version 17.0; SPSS, Inc., Chicago, Illinois, USA), and Microsoft Excel 2003.

III. RESULT AND ANALYSIS

A. Effects of SAP on the Root Activities

With the increasing of low temperature stress, the root activities decreased (Fig. 1). SAP has significant effects on root activities. After SAP was applied, the root activities have increased. With the increasing of time, the root

activities decreased, which is 1.04, 0.83 and 0.74 mg g⁻¹ h⁻¹ by average at 24th, 48th and 72nd hour respectively. With the decreasing of temperature, the root activities decreased, which is 1.63, 1.18, 0.37 and 0.29 mg g⁻¹ h⁻¹ by average at 5 °C, 0 °C, -5 °C and -10 °C respectively.

B. Effects of SAP on the Cell Membrane Permeability

With the increasing of low temperature stress, the relative electrical conductivities increased (Fig. 2). After

SAP was applied, the relative electrical conductivities have decreased. With the increasing of time, the relative electrical conductivities increased, which is 37.44%, 46.57% and 53.53% by average at 24th, 48th and 72nd hour respectively. With the decreasing of temperature, the relative electrical conductivities increased, which is 9.41%, 24.98%, 68.92% and 80.06% by average at 5 °C, 0 °C, -5 °C and -10 °C respectively.

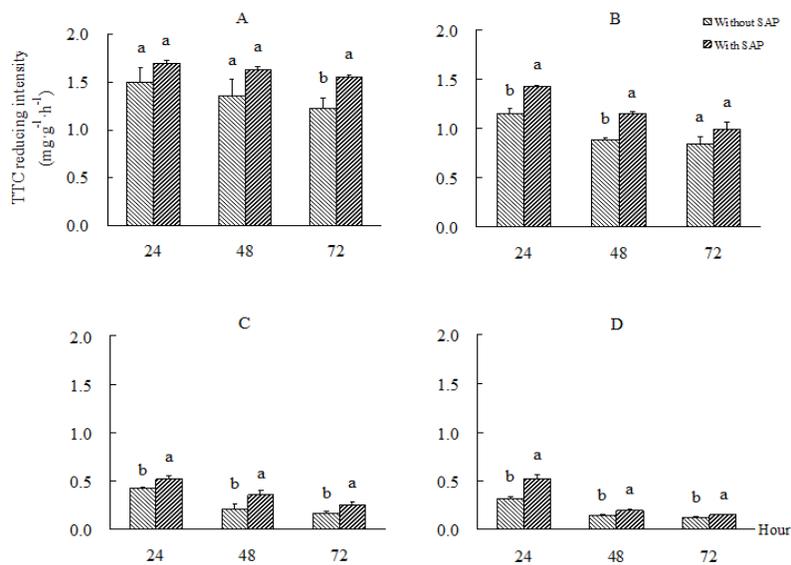


Fig. 1 Effects of SAP on the root activities under low temperature stress
Note: A, B, C, D represent 5 °C, 0 °C, -5 °C, -10 °C processing, respectively. Different letters significant difference at 0.05 level.

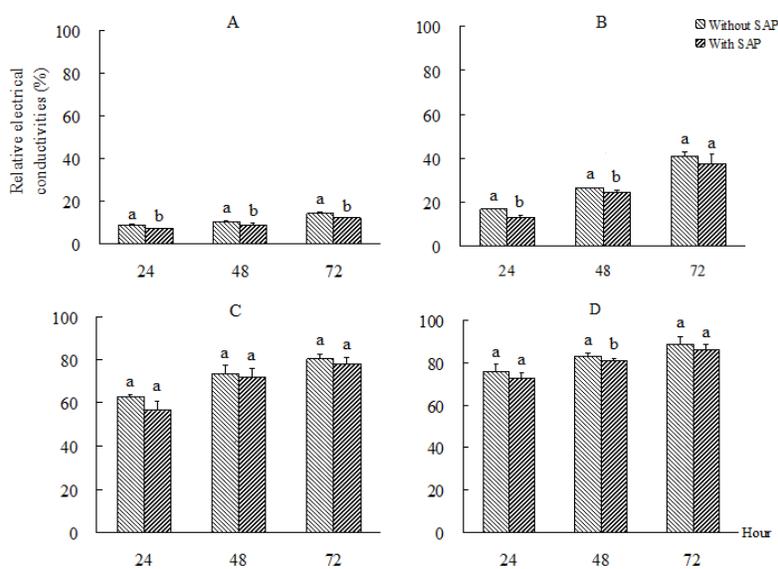


Fig. 2 Effects of SAP on the relative electrical conductivities under low temperature stress
Note: A, B, C, D represent 5 °C, 0 °C, -5 °C, -10 °C processing, respectively. Different letters significant difference at 0.05 level.

C. Effects of SAP on the Pro Contents

With the increasing of low temperature stress, the proline contents increased (Fig. 3). After SAP was applied, the proline contents have increased. With the increasing of time, the proline contents increased, which is 121.65,

159.27 and 217.61 $\mu\text{g g}^{-1}$ by average at 24th, 48th and 72nd hour respectively. With the decreasing of temperature, the proline contents increased, which is 56.98, 86.17, 159.53 and 362.01 $\mu\text{g g}^{-1}$ by average at 5 °C, 0 °C, -5 °C and -10 °C respectively.

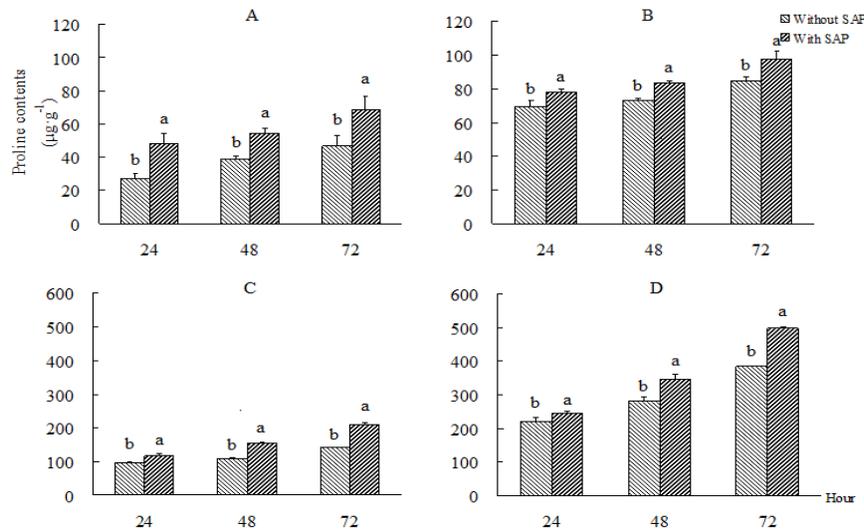


Fig. 3 Effects of SAP on the pro contents under low temperature stress

Note: A, B, C, D represent 5 °C, 0 °C, -5 °C, -10 °C processing, respectively. Different letters significant difference at 0.05 level.

D. Effects of SAP on the MDA Contents

With the increasing of low temperature stress, the malondialdehyde contents increased (Fig. 4). After SAP was applied, the malondialdehyde contents have decreased. With the increasing of time, the malondialdehyde contents

increased, which is 11.03, 14.40 and 18.54 mmol g^{-1} by average at 24th, 48th and 72nd hour respectively. With the decreasing of temperature, the malondialdehyde contents increased, which is 10.62, 12.26, 13.47 and 22.25 mmol g^{-1} by average at 5 °C, 0 °C, -5 °C and -10 °C respectively.

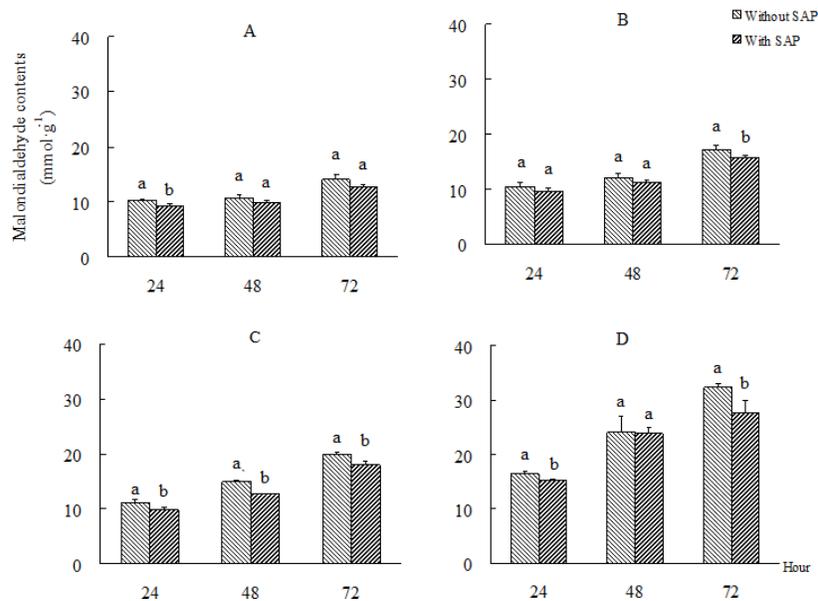


Fig. 4 Effects of SAP on the MDA contents under low temperature stress

Note: A, B, C, D represent 5 °C, 0 °C, -5 °C, -10 °C processing, respectively. Different letters significant difference at 0.05 level.

E. Effects of SAP on the SOD Activities

With the increasing of low temperature stress, the superoxide dismutase activities increased (Fig. 5). After SAP was applied, the superoxide dismutase activities have increased. With the increasing of time, the superoxide dismutase activities decreased, which is 765.25, 681.76 and

587.13 U g^{-1} by average at 24th, 48th and 72nd hour respectively. With the decreasing of temperature, the superoxide dismutase activities decreased, which is 725.85, 737.44, 710.88 and 538.01 U g^{-1} by average at 5 °C, 0 °C, -5 °C and -10 °C respectively.

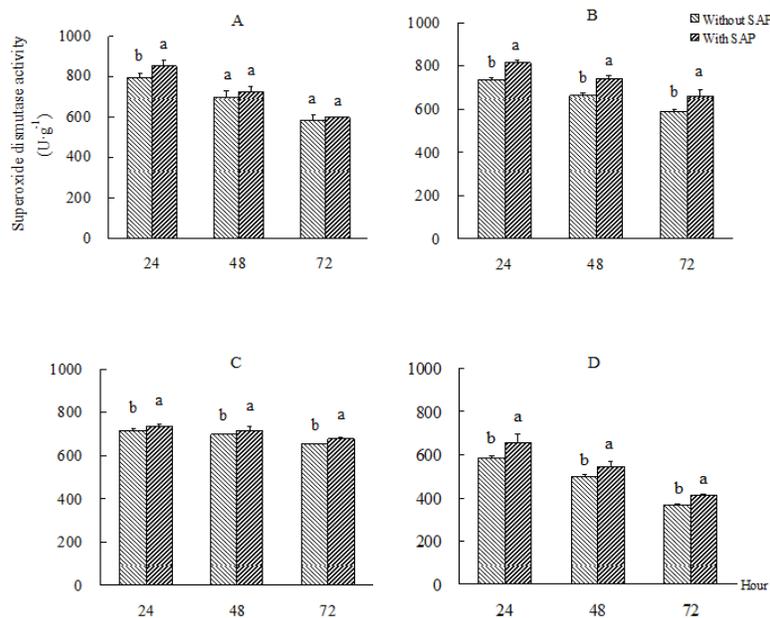


Fig. 5 Effects of SAP on the SOD activities under low temperature stress

Note: A, B, C, D represent 5 °C, 0 °C, -5 °C, -10 °C processing, respectively. Different letters significant difference at 0.05 level.

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