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Application of boron, copper, and silicon for plant diseases control in turfgrass Bermuda cv Satiri

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Abstract: Although many states recommend boron, copper and silicon fertilizer for fruit, vegetable crops and other crops but the information about boron, copper and silicon fertilization of turf grasses are lacking for plant diseases control. The objective of this experiment was to evaluate the effect of boron, copper and silicon on growth and to suppress fungal diseases development in Bermuda cv 'Satiri'. This experiment was conducted in the Unit Latihan Turf, Universiti Putra Malaysia.Four levels of single boron, copper and silicon namely 0, 5, 10 and 20 ppm were applied through soil drench for with and without fungal disease. Boron fertilization was causing the toxicity and effect the slow growth on Bermuda cv 'Satiri. It also decreases disease resistant on Bermuda cv 'Satiri. Highest density was found in T5 (229.25/cm2) and lowest value was in T2 (132.25/cm2).The growth and disease resistant of Bermuda cv 'Satiri' were affected by copper and silicon fertilization in high concentration. Highest concentration boron (20ppm) with Rhizoctonia produced the lowest disease severity (30-41%).
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1. Introduction

Turfgrasses are among the most important industries in many countries including Malaysia. Maintained turfgrass, from roadsides to putting greens, encompasses a considerable portion of the landscape mainly because of its recreation amenity (Juraimi, 2001). Thus, the most turfgrasses that widely used in tropical and subtropical regions is Bermudagrass (Cynodon species). One of the new turfgrasses that were used widely on green is Bermuda grass cv 'Satiri'. Bermuda cv 'Satiri' was launched in 2008 and now is being used in Universiti Putra Malaysia golf courses and several other golf courses in Malaysia. Bermuda 'Satiri' has good characteristics than the other turfgrass. It has fine texture, shorter internodes, and leaf and higher shoot density make the surface of the green have more ball speed. It has also moderate tolerance to shade, drought salinity tolerance (Uddin et al, 2011, 2012). Bermuda cv 'Satiri' need certain nutrients in the right amounts to grow properly and maintain good health. Boron and copper are two essential micro nutrients; and silicon, though not essential, play very important roles for agricultural and horticultural crops (Brady, 2004). The beneficial effects of boron, copper and silicon, direct or indirect to plants under abiotic and/or biotic stress; have been reported to occur in turfgrass (Stenotaphrumsecundatum) (Datnoffetet al., 2001). Boron plays an important role in cell wall synthesis (Marschner, 1995). Copper is influential in plant enzymatic activity, and it performs key functions in cell wall lignin process, plant respiration, and photosynthesis (Marschner, 1995). Significant effects of silicon on plants includes suppression of insect feeding and plant diseases (Datnoff, and Rodrigues, 2005; Savant et al., 1997) and improvement of leaf and stem strength through deposition in the cuticle and by maintaining cell wall polysaccharides and lignin polymers (Hull, 2004). The objectives of this research were to determine the best rates of boron, copper and silicon singly to suppress fungal disease development in Bermuda cv 'Satiri'.

2. Materials and methods

This experiment was conducted in the Unit Latihan Turf, Universiti Putra Malaysia. It was started on 9 September 2011. Plastic pots (37 cm x 26.5 cm x 10 cm) were filled up with sandy soil (a mixture of river sand and peat; 4:1 ratio). All pots were fertilized with NPK Green (15:15:15) (50 kg N/ha) every two weeks. Insecticides such as Diazinon

and Malathion were applied for insect and disease control. The native soil on the grasses (Bermuda cv Satiri) that are obtained from Turf Nursery UPM were washed from the stolon and then stolon were transplanted into the plastic pots and grown for 12 weeks with fresh irrigation water in order to achieve full establishment (3 times per day during establishment and 2 times per day at mature stage using automated sprinkler system). Grasses were clipped by scissors throughout the experiment at the cutting height of 5 mm. Four levels of boron, copper and silicon namely 0, 5, 10 and 20 ppm were applied through soil drench every 1 weeks for 8 weeks with and without fungal. Boron (Boron trioxide B2O3, copper (Copper II Sulphate CuSO4.5H2O) and silicon (Sodium Silicate SiO2) with 100 ml spray volume of solutions was used in each tray by using 500 ml hand sprayer. For treatment with fungal diseases, the wheat cultures of Rhizoctonia spp. (followed method of Wilkinson (1988) and Blazier and Conway (2004) with slightly modification) were inoculated on Bermuda cv 'Satiri' after 8 weeks of micronutrient application. Shoot density, shoot and root dry weight, total dry weight, root volume and disease severity were recorded one month after Rhizoctonia spp. inoculation. The design was laid out according to RCBD with four replications. Data were subjected to ANOVA using the Statistical Analysis System (SAS) software (version 9.0). The treatment means were compared by Tukey at the 5% probability level.

Table 1: List of treatment for boron copper and silicon with and without fungal diseases on Bermuda cv 'Satiri'.

SL	Treatment
T1	Satitri (Control)
T2	Satiri + Rhizoctonia spp.
T3	Satiri + Boron 5 ppm
T4	Satiri + Boron 10 ppm
T5	Satiri + Boron 20 ppm
T6	Satiri + Boron 5 ppm + Rhizoctonia spp.
T7	Satiri + Boron 10 ppm + Rhizoctonia spp.
T8	Satiri + Boron 20 ppm + Rhizoctonia spp.
T9	Satiri + Copper 5 ppm
T10	Satiri + Copper 10 ppm
T11	Satiri + Copper 20 ppm
T12	Satiri + Copper 5 ppm + Rhizoctonia spp.
T13	Satiri + Copper 10 ppm + Rhizoctonia spp.
T14	Satiri + Copper 20 ppm + Rhizoctonia spp.
T15	Satiri + Silicon 5 ppm
T16	Satiri + Silicon 10 ppm
T17	Satiri + Silicon 20 ppm
T18	Satiri + Silicon 5 ppm + Rhizoctonia spp.
T19	Satiri + Silicon 10 ppm + Rhizoctonia spp.
T20	Satiri + Silicon 20 ppm + Rhizoctonia spp.

3. Results and discussion

Effect of boron application on Bermuda cv "Satiri"

Due to application of boron Table 2 showed that the shoot density total dry weight and root volume were increasing with increasing concentration of boron. Highest density was found in T5 (229.25/cm2) and lowest value was in T2 (132.25/cm2). Treatment T3 produced the highest total dry weight (8.95 g/ cm2) while T2 produced the lowest (6.57 g/ cm2). Highest root volume was found in T3 (30 $cm^3/25cm^2$) and lowest was found in T8. The effect of the B treatments on bermuda grasses was an increase in dry matter (DM) yield when 2.2 kg ha−1 B was applied annually (Warren et al., 1986).

Effect of cupper application on Bermuda cv "Satiri"

Table 2 showed that the shoot density, root dry weight, shoot dry weight, total dry weight and root volume were increasing with concentration with copper but its decrease in 20 ppm. Treatment T10 and T13 produced the highest shoot density. Highest total dry weight was found in T10 (174 g/ cm2) and T13 while lowest was found in T12 (171 g/ cm2).

Root volume of Bermuda cv "Satiri" produced highest value in T10 (27.50 cm³/25cm²).

Effect of silicon application on Bermuda cv "Satiri"

Table 2 revealed that T16 had the highest shoot density (246/cm2) but lowest was in T20 (162.50/cm2). For total dry weight, highest value was found in T16 (16.79 g/ cm2) and lowest was found in T18 treatment (7.12 g/ cm2). Highest root volume was found in T15 treatment (35 cm³/25cm²). Silicon effects on nodule growth, dry-matter production of cowpea (Vigna unguiculata) (Mali and Aery, 2008). Since Si improves leaf and stem strength through deposition in the cuticle and by maintaining cell wall polysaccharide and lignin polymers, the possibility exists that Si could improve wear tolerance (Hull et al, .2004, Brecht et. al. 2004).

Table 2: Effect of boron, copper and silicon with and without fungal diseases on Bermuda cv 'Satiri' growth.

Treatment	Shoot density (no/25cm²)	Root dry weight (g/25cm²)	Shoot dry weight (g/25cm²)	Total dry weight (g/25cm²)	Root volume (cm³/25cm²)
T1	152.50	4.87	2.51	7.39	22.50
T2	132.25	4.38	2.18	6.55	22.50
T3	186.25	6.47	2.49	8.95	30.00
T4	189.50	6.20	2.75	8.94	28.75
T5	229.25	5.44	2.84	8.28	27.50
T6	135.75	4.83	2.47	7.29	22.50
T7	139.50	4.78	2.41	7.19	22.50
T8	158.50	4.38	2.65	7.03	20.00
T9	171.00	4.52	3.19	7.71	22.50
T10	174.00	5.72	3.43	9.16	27.50
T11	173.25	4.86	3.36	8.22	25.00
T12	171.00	4.52	3.19	7.71	22.50
T13	174.00	5.72	3.43	9.16	27.50
T14	173.25	4.86	3.36	8.22	25.00
T15	244.25	13.45	3.29	16.75	35.00
T16	246.00	13.36	3.43	16.79	32.50
T17	219.75	13.50	2.12	15.63	37.50
T18	173.25	4.47	2.47	7.12	27.50
T19	176.00	4.68	2.65	7.14	30.00
T20	163.50	4.80	2.41	7.21	33.75
Level of significance	69.07	3.84	1.66	4.58	15.78

Effect of Boron, Copper and Silicon on disease severity

After application of boron, cupper and silicon with fungal had significant effect on disease severity (Table 3). Due to effect of Rhizoctonia fungal disease severity was increased from 1st week to 3 week and highest disease severity was found (71.25%). Highest concentration boron (20ppm) with Rhizoctonia produced the lowest disease severity (30-41%) compared to lower concentrations. Medium concentration of cupper and silicon (10ppm) with Rhizoctonia produced the lowest disease severity 25% and 27.50% respectively. Silicon also has been effective in suppressing diseases in a number of warm- and cool-season turfgrass species. Silicon has increased the resistance of zoysiagrass to Rhizoctonia solani (31); creeping bentgrass to Pythium aphanidermatum, Sclerotinia homoeocarpa, and R. solani (15,28,30,34,37); and in Kentucky bluegrass to powdery mildew (Sphaerotheca fuliginea (Hamel and Heckman, 1999).

Table 3: Disease severity in Bermuda cv 'Satiri' for application of Boron, Copper and Silicon at 1st, 2nd, and 3rd weeks.

	Treatment	Week 1	Week 2	Week 3
1	Satiri + *Rhizoctonia spp.*	51.25%	60.00%	71.25%
2	Satiri + Boron 5 ppm + *Rhizoctonia spp.*	47.50%	53.75%	62.50%
3	Satiri + Boron 10 ppm + *Rhizoctonia spp.*	36.25%	46.25%	51.25%
4	Satiri + Boron 20 ppm + *Rhizoctonia spp.*	30.00%	35.00%	41.25%
5	Satiri + Copper 5 ppm + *Rhizoctonia spp.*	42.50%	47.50%	52.50%
6	Satiri + Copper 10 ppm + *Rhizoctonia spp.*	37.50%	32.50%	25.00%
7	Satiri + Copper 20 ppm + *Rhizoctonia spp.*	40.00%	38.75%	36.25%
8	Satiri + Silicon 5 ppm + *Rhizoctonia spp.*	46.25%	38.75%	33.75%
9	Satiri + Silicon 10 ppm + *Rhizoctonia spp.*	42.50%	36.25%	27.50%
10	Satiri + Silicon 20 ppm + *Rhizoctonia spp.*	52.50%	46.25%	37.50%

4. Conclusion

Application of boron was causing the toxicity and effect the slow growth on Bermuda cv 'Satiri. It also decreases disease resistant on Bermuda cv 'Satiri. Application of copper and silicon increase the growth of Bermuda cv 'Satiri' until 10 ppm and the growth were decrease with high concentration. This experiment showed that copper and silicon increase disease resistant on Bermuda cv 'Satiri'. 10 ppm of copper and silicon was suitable for disease resistant as well as growth performance of Bermuda cv 'Satiri.

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