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Short communication

Brown patch severity of lawn grass species as influenced by weather parameters in mid-hills of Himachal Pradesh

ABHISHEK SHARMA[1], ASHNA ACHARYA[2*] and JASBIR SINGH WAZIR[3]

[1]Department of Plant Pathology, Dr. Y S Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh, India
[2]Department of Floriculture and Landscape architecture, Dr. Y S Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh, India*
[3]Department of Floriculture and Landscape Architecture, Dr. Y S Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh, India
**Email of the corresponding author: ashnaacharya1997@gmail.com*

Turfgrass industry is now known as "billion-dollar industry" for making a significant contribution to the economy worldwide. Many states in the U.S. revealed it as the highest income generating sector (Breuninger *et al.,* 2013). Turfgrass research and development is still at its infancy in India. Recently there has been an increased demand of amenity grasses for various purposes, be it home gardens, school parks, offices and hospitals etc. Under all situations grasses undergo various stress conditions like frequent mowing, human traffic, drought and heavy rains etc. Lawn is regarded as the heart of garden and any negligence in its maintenance may cost the beauty of the garden. Though selected for their wear and tear bearing capacity, lawn grasses are frequently prone to a variety of diseases especially due to prevailing congenial weather conditions which support the growth of numerous pathogens. One such disease is brown patch disease or Rhizoctonia blight caused by '*Rhizoctonia solani* Kuhn'. It is regarded as one of the most economically important diseases of turfgrasses which can affect both cool-season grasses such as perennial ryegrass, creeping bentgrass, tall fescue, and annual bluegrass (referred to as "brown patch") as well as warm-season grasses like zoysiagrass and bermuda grass (referred to as "large patch") (Hyakumachi *et al.,* 1998). 'R. *solani*' is a soil-borne basidiomycetous fungus which causes foliar blight of turfgrasses. The disease first appears as circular to irregular blighted areas which are purplish green during early stages and later turning light brown. The most characteristic symptom of the disease is formation of "smoke rings" i.e. the appearance of white tufts of mycelium bordering the infected areas in the early mornings. The disease is erumpent during the periods of high temperature, humidity and water on the surface of leaves (Couch 1995). In 1993, it was found that 30% of all fungicide spent in turfgrass industry was allocated for managing brown patch (Palmieri *et al.,* 2006). Many homeowners regularly try to control brown patch using fungicides (Koehler *et al.,* 2017). The appearance of 'R. *solani*' may be accurately predicted based on meteorological data, thereby limiting the application of control measures (fungicidal treatment or attrition by sweeping the surface of the turf with a bamboo pole) to the critical periods and so affecting a considerable economy. However, attempts made previously to relate brown patch disease with environmental conditions were met with scepticism due to uncertainty in accurate weather forecasting. Later, with advancement in weather forecasting, weather-based disease forecasting systems resurfaced in the 1980s and 1990s. As knowledge regarding the disease is lacking from the Indian subcontinent, this study focuses on the severity of the disease on the turfgrass industry and identifying key environmental factors congenial for disease development. The expected results can contribute towards diagnosis and forecasting of the disease which can be utilized to devise economically viable management strategies.

The experiment was carried out at the experimental farm of Department of Floriculture and Landscape Architecture, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, (HP) during 2020-21 under natural field conditions. The seeds of different lawn species were sown in plots of one meter square in three replications each in Randomised Block Design (on 20th March 2020). Data on disease severity of four different lawn grass species i.e., cool season grasses namely, *'Lolium perenne'*, *'Agrostis stolonifera'* and '*Festuca rubra'* and a warm season grass i.e., *'Cynodon dactylon'* (procured

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Table 1: Brown patch disease rating based on 0-9 scale by Green *et al.,* (1994)

Rating	Area with patch symptoms (%)	Area (cm^2)
0	No patches	0
1	1 to 11	100-1100
2	12 to 22	1200-2200
3	23 to 33	2300-3300
4	34 to 44	3400-4400
5	45 to 55	4500-5500
6	56 to 66	5600-6600
7	67 to 77	6700-7700
8	78 to 88	7800-8800
9	>88	>8800

from DLF Pickseed, Halsey, Oregon USA through Peak Traders, Gurgaon) was recorded at biweekly interval after the plots were completely covered with turfgrass i.e. form May 2020 to April 2021. The data on weather parameters were obtained from the meteorological observatory, Department of Environment Science, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) to find out their effect on disease development. Further, simple correlation and regression coefficients were calculated following the procedure by Gomez and Gomez (1984), and regression equations were constructed.

The data on disease severity was recorded at biweekly interval by disease rating based on 0-9 scale (Table 1) (Green *et al.,* 1994) and was averaged for the month in consideration.

The disease severity was calculated by using the formula given by McKinney (1923) as follows:

Disease severity (%)

$$= \frac{\text{Sum of all disease ratings}}{\text{Total number of samples observed} \times \text{Maximum disease grade}} \times 100$$

Data was analyzed and regressions equations and plots were developed using SPSS v. 20. Also, correlation heat maps were generated to visually evaluate the role of each factor on disease severity.

The meteorological data and severity of the disease recorded at biweekly interval and averaged to monthly data, commencing from May 2020 to April 2021 is presented in Table 2. The initiation of disease vis-a-vis weather parameters depicted that the disease first appeared in May, 2020 - June, 2020 on 'F. *rubra*', 'A. *stolonifera*' and 'L. *perenne*' whereas in 'C. *dactylon*', a warm season grass, disease initiated during early fall i.e. July-August. These results are in concordance with Couch (1995), who concluded that infection in cool season grasses is predominant in summer months whereas infection in warm season grasses occurs primarily in spring and fall. The prevalence of congenial weather conditions such as 29.7 and 30.8°C mean maximum temperature; 14.4 and 17.3°C mean minimum temperature; 74.8 and 58.7 mm cumulative rainfall and 53 and 64 per cent mean relative humidity in May and June, respectively initiated disease development in cool season grasses whereas disease development in warm season grass was supported by high humidity and rainfall. Maximum disease severity was observed in '*F. rubra*' (21.6%) followed by 'L. *perenne*' (17.9%) and 'A. *stolonifera*' (17.6%) whereas the least was in 'C. *dactylon*' (3.9%). Earlier, Kusvuran and Tansi (2014) reported that most negatively affected grass as compared to other species during high temperature was red fescue including all its subspecies and varieties. Survival percentage was less for fescue and creeping bentgrass cultivars as reported by Chang and Lee (2010). 'C. *dactylon*' showed less susceptibility to the disease and the disease disappeared after a short spell of time with its peak severity during the fall season. Also, disease was more pronounced in cool season grasses than in warm season grasses (Table 2) indicating that 'C. *dactylon*' was relatively resistant to the disease than other cool season grasses.

The correlation between disease severity and meteorological parameters was positive in all the grasses revealing a strong association among the variables. In most of the grass species, a significant and strong correlation was observed with respect to minimum temperature and relative humidity emphasizing the importance of warm and humid conditions in disease development, whereas maximum temperature and average rainfall was showing moderate to low but positive correlation (Table 3). These results are in line with Cutulle (2011) who found that high humidity and night temperature of no lower than 21˚C are required by 'R. *solani*' to parasitize the turfgrass foliage. Since simple correlation data was showing high level of multicollinearity, partial correlation coefficients were deduced to check the individual impact of variables, while controlling for other variables, on disease severity. The data in the (Table 4) points that relative humidity had the most impact on disease severity in cool season grasses whereas rainfall was significantly contributing for disease development in warm season grass i.e. 'C. *dactylon*'. However, partial correlation coefficient between disease severity and minimum temperature in all the grasses was not significant (Table 4). This points that minimum temperature influences disease severity in combination with other factors. R square value tells us about the per cent of variation described by the independent variables as in case of 'F. *rubra'* 92.2 percent of the variation in disease severity is attributed to various meteorological parameters and rest 7.2 per cent is unexplained variability. Similarly, 82.6 percent in 'L. *perenne'*, 86.6 percent in 'A. *stolonifera*' and 73.1 per cent in 'C. *dactylon*' variation can be explained with these variables (Table 5). Nainwal *et al.,* (2024) found that 56 to 74.8 per cent variation in Rhizoctonia aerial blight disease of soyabean can be explained with independent variables, maximum temperature (>34 ºC), morning relative humidity (93%), rainfall (76.2 mm) and sunshine hours. Xiang *et al.,* (2019) revealed that the higher disease severity of brown patch disease caused by the fungus '*R. solani* Kühn' AG-2–2 IIIB was observed in years when the temperatures were comparatively warmer and in denser plant canopies due to higher relative humidity. Powlen *et al.,* (2024) while evaluating relationship between N-fertilization rate and brown patch severity in cool season turfgrass species viz., creeping bentgrass (A. *stolonifera*), colonial bentgrass (A. *capillaris* L.), perennial ryegrass (L. *perenne*) and turf type tall fescue (*Schedonorus arundinaceus* (Schreb.) observed that under controlled conditions in experiment

Table 2: Monthly meteorological data with corresponding disease severity of lawn grass specie.

Month	Maximum temp (˚C)	Minimum temp. (˚C)	Relative humidity (%)	Rainfall (mm)	Disease severity (%)			
					L. *perenne*	A. *stolonifera*	F. *rubra*	C. *dactylon*
May, 2020	29.7	14.4	53.0	74.8	0.0	5.6	9.3	0.0
June, 2020	30.8	17.4	64.0	58.7	16.7	18.5	29.6	0.0
July, 2020	30.2	19.9	76.0	278.1	48.1	46.3	63.0	0.0
August, 2020	29.2	20.7	81.0	148.6	66.7	61.1	68.5	25.9
September, 2020	30.6	17.6	68.0	6.0	44.4	46.3	44.4	16.7
October, 2020	29.8	11.0	55.0	0.0	27.7	27.8	24.1	3.7
November, 2020	23.7	5.6	55.0	37.7	11.1	5.6	7.4	0.0
December, 2020	21.9	2.5	50.0	23.8	0.0	0.0	1.9	0.0
January, 2021	20.5	2.3	58.0	21.3	0.0	0.0	0.0	0.0
February, 2021	23.0	4.8	62.0	59.7	0.0	0.0	0.0	0.0
March, 2021	27.3	9.0	43.0	14.8	0.0	0.0	0.0	0.0
April, 2021	25.4	10.8	55.0	65.9	0.0	0.0	11.1	0.0
Mean					17.9	17.6	21.6	3.9

Table 3: Simple correlation coefficient between disease severity and meteorological factors

Meteorological factors	L. *perenne*	A. *stolonifera*	F. *rubra*	C. *dactylon*
Maximum temp.	0.620	0.683	0.692	0.390
Minimum temp.	0.781	0.824	0.878	0.559
Relative humidity	0.855	0.848	0.886	0.653
Rainfall	0.537	0.524	0.676	0.125

Table 4: Partial correlation coefficients between disease severity and meteorological factors

Meteorological factors	L. *perenne*	A. *stolonifera*	F. *rubra*	C. *dactylon*
Maximum temp.	0.264	0.347	0.172	-0.398
Minimum temp.	-0.072	-0.083	0.190	0.481
Relative humidity	0.702*	0.737*	0.710*	0. 480
Rainfall	-0.160	-0.219	0.136	-0.716*

Table 5: Regression equations and coefficient of determination ($R^{2)}$ values

Lawn grass species	Regression equation	R^2
L. *perenne*	$Y= -157.931 +2.754X_1 -0.525X_2 +1.832X_3 -0.031X_4$	0.826
A. *stolonifera*	$Y= -159.376 +3.110X_1 -0.510X_2 +1.694X_3 -0.036X_4$	0.866
F. *rubra*	$Y= -103.942 +1.243X_1 +1.004X_2 +1.326X_3 +0.018X_4$	0.922
C. *dactylon*	$Y= 14.415 -1.95X_1+ 1.79 X_2+ 0.45 X_3 -0.08X_4$	0.731

Note: Where, Y= Disease Index (%); X_1= Maximum Temperature (˚C); X_2= Minimum Temperature (˚C); X_3= Average Relative Humidity (%); X_4= Cumulative Rainfall (mm)

1 higher disease severity was recorded as compared to experiment 2 due to higher relative humidity and higher leaf wetness duration in experiment 1.

The present study elucidates that the key parameters influencing brown patch development in cool season as well as warm season grasses. Variability in disease development in cool season grasses can be attributed to independent variables, max and min temperature, mean relative humidity and cumulative rainfall whereas in warm season grasses, relative humidity and rainfall, were the significant parameters influencing disease development. By keeping these factors in mind, the spray schedule should begin before the relative humidity and temperature starts to increase. Prophylactic sprays can come in handy when sprayed in late March to early May in reducing the severity of diseases. Regression analysis revealed that meteorological parameters could explain most of the variation in disease severity. This study is a first systematic attempt in identifying key environmental parameters influencing brown patch disease severity in turfgrasses in Indian subcontinent.

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