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Research Article

Physiological Parameters of Barley as Affected by Stripe Disease

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ABSTRACT

Stripe disease of barley caused by Drechslera graminea (Rabenh.) Shoemaker is a widely distributed disease in many barley grown parts of the world, but it has assumed more importance with the introduction of some new high yielding varieties. The present investigations were undertaken during 2007-08 and 2008-09 crop seasons with a view of elicit information on effect of disease on physiological parameters particularly chlorophyll content, leaf area, photosynthesis, stomatal conductance and transpiration. Stripe infection resulted in reduction of all the physiological parameters at both the stages i.e. 35 days and 50 days after disease appearance.

Keywords: *Barley, Stripe disease, Chlorophyll, Photosynthesis, Stomatal conductance, Transpiration, leaf area.*

INTRODUCTION

Barley (*Hordeum vulgare* L.) is an important cereal crop in the world with an annual production of around 132 million tons, ranking next to maize, wheat and rice. It is one of the earliest domesticated food crops. In India, it is an important *rabi* season cereal crop in Punjab, Rajasthan, Madhya Pradesh, Haryana, Uttar Pradesh and Bihar. Total area under this crop in India is 656.25 thousand ha, with a production of 1747.45 thousand tons and an average productivity of 2663 kg/ha in 2016-17. Total area under this crop in Haryana is 20 thousand ha with a production of 73 thousand tones and an average productivity of 3650 kg/ha during 2016-17 (Anonymous, 2018).

Barley is hardier than wheat crop and is inherently equipped to adapt itself admirably well under limited inputs and marginal lands. Because of its most versatile agro climatic adaptability even the high yielding varieties of wheat could not replace barley in the wheat bowls of India on rainfed, saline, alkaline soils and dryland etc. The raw material of barley is utilized for malting and brewing purpose besides food grain and cattle feeds. Barley crop suffers from a number of diseases such as stripe rust, leaf rust, covered smut, loose smut, net blotch, stripe disease and leaf blight etc. which cause significant losses to crop yield. Among these fungal disease, stripe disease (*Drechslera graminea* Rabenh.) Shoemaker is an important disease which may cause crop loss upto 70-72 per cent under epiphytotic conditions (Pant & Bisht, 1983). Due to the extensive cultivation of high yielding barley varieties, the problem of stripe disease has assumed a significant importance.

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The pathogen is seed borne in nature and it survives exclusively as mycelium on peri- carp or hull of the seed.

Diseased plant arise only from infected seeds and they become systematically infected, senescence early and produce a poor yield due to shrivelled seed. There is no spread of infection between plants during the growing season. The fungus produces masses of conidia (anamorph of *Drechslera graminea*) on leaves of diseased plants. These conidia are carried by the wind to developing seed on the ear of healthy plants with in the crop and in neighbouring crops. Developing barley seed is susceptible to infection from anthesis to soft dough stage (Teviotdale & Hall, 1976). Since, some of the spores germinate and infect the developing seed, there is potential for infection to multiply significantly from one season to next season.

The pathogen has been reported as an obligate parasite, and practically no authentic record have been produced yet that conidia are produced on artificial media. But on the other hand, it has been reported that this pathogen successfully sporulates on the lesions on the foliages and glumes under natural conditions.

In Haryana, the disease was first reported by Tyagi (1974) on variety C-138 and in 1976 Harichand further reported on many commonly grown varieties. Disease plant arise only from infected seeds. After the germination of the seed, the pathogen becomes systemic and the plants senesence early and produce poor yield due to the shriveled grains. There is no secondary spread of infection. Since, these conidia germinate and infect the developing seed, so there is potential for the production of diseased seed, which act as source of infection for the next season. Being a seed borne disease, it is observed where the barley crop is grown throughout the world.

Stripe disease incited by *Drechslera graminea* (Rabenh.) Shoemaker is very destructive disease of irrigated barley crop. This disease is very serious throughout the world,wherever barley is cultivated. It is also common in North India, particularly in Haryana and Rajasthan states and causes hugs loss in grain yield. The disease has been reported from Europe, U.S.A, South Africa, Chin and Japan.

Keeping this view in mind, an attempt was made to study the effect of stripe disease on biochemical and physiological parameters, yield parameters and its management through cultural and chemical means.

MATERIALS AND METHODS

The present investigation entitled, “Physiological parameters of barley as affected by stripe disease” were carried out during 2007-08 and 2008-09 *rabi* seasons. The field experiments were conducted at the experimental research area of the Department of Plant Pathology, CCS Haryana Agricultural University, Hisar located at 215.2 M above the mean sea level with a longitude of 75º46'E and latitude of 29º10'N has a wide range of temperature fluctuation during summer and winter seasons and is characterized as a Semi arid Zone. The minimum and maximum temperature ranges from 0ºC to 48ºC, respectively. The annual average rainfall is 430mm. The major part of rainfall is received during monsoon season which occurs from July to September. A few millimeters of rainfall can be expected in winter too.During 2007-08 crop season the diseased plants were selected at the experimental research area Department of Plant Breeding (Wheat and Barley section), CCS Haryana Agricultural University, Hisar in the seed production area of variety BH-393. At maturity these selected plants were harvested separately, thrashed and the seed obtained was used for carrying out further studies. Highly susceptible barley variety BH393 was sown in field in a plot size of 2 x 1.5m in the research area of Department of Plant Pathology.

Observations on physiological parameters of healthy and diseased plants were recorded after 35 and 50 days of disease appearance. All the physiological studies viz.

Photosynthesis, transpiration rate and stomatal conductance were measured by monitoring changes in CO_2 concentration using Infra Red Gas Analyser (IRGA, Portable, fitted with Data lodger LCA-2 ADC type) at 35 and 50 days after disease appearance. The observations were recorded between 11.00-13.00 h during the period when light intensity was more than 650 µE/m^2/s. The instrument was allowed to warm up for half an hour and then leaf samples were introduced in IRGA and observations obtained by data lodger.

Leaf area was measured by leaf area meter. Ten plants, diseased as well as healthy, were tagged in variety BH 393 plot. All the leaves of plants ie. from first to six, were measured by leaf area meter. The total area of the leaves of the healthy as well as diseased was measured after 35 and 50 days after disease appearance. The per cent loss or reduction in leaf area of the diseased plants was calculated on the basis of leaf area of healthy plants leaves. Chlorophyll content of healthy leaves and diseased leaves was determined by the method of Arnon (1949) after 35 and 50 days after disease appearance.

RESULTS

It is evident from the data in (see in Table) that by and large, the stripe infection resulted in reduction of all the physiological parameters at both the stages i.e. 35 days and 50 days after disease appearance. The chlorophyll content estimated in leaves of barley variety BH-393 at two stages revealed a tremendous reduction in chlorophyll content from 35 days after disease appearance onwards. The stripe disease induced maximum reduction in total chlorophyll i.e. 74.58 per cent after 50 days after disease appearance and the reduction in total chlorophyll after 35 days of disease appearance was 70.25 per cent. Some other workers (Akai & Fukutomi 1958, 1964a; Safeeulla, 1976) have also found a decreased chlorophyll content in the diseased leaf tissue of rice and finger millet due to *Sclerophthora macrospora* respectively. Garg & Mandhar (1975) found 60% decrease in the total chlorophyll content of pearl millet leaves infected with *S. graminicola.* Bhatia and Thakur (1991) also recorded a decrease in total chlorophyll content in pearl millet leaves infected with *S. graminicola*. Similarly, Junkueira et al., (2005) reported reduction in chlorophyll content in corn leaves infected with maize bushy stunt phytoplasma. Our results are in agreement with the above workers. However, Singalovsky (1937) and Kupreviez (1947) stated that loss of chlorophyll is not one of the first symptoms of disease but occurs in later stages of systemic infection caused by many different obligate parasites. The decrease in chlorophyll content in diseased leaves seem to be attributed to the restriction of space for the chloroplast development.

All the leaves from diseased and healthy plants after 35 days and 50 days of disease appearance were detected and their area was measured by leaf area meter under laboratory conditions. The data revealed that the leaf area was reduced significantly in diseased leaves after 35 days and 50 days after disease appearance. The total leaf area of healthy leaves after 35 days was 50.25 and after 50 days was 60.2 (cm^2). However, in diseased leaves, the total leaf area after 35 days and 50 days after disease appearance was 31.1 and 31.5 (cm^2), respectively. The reduction in total leaf area was more in 50 days after disease appearance i.e. 47.67 per cent than at 35 days i.e. 38.10 per cent. Dharamveer (2002) also rerpoted that leaf area was reduced significantly in highly susceptible cultivars of wheat against *Urocystis agropyri* as compared to resistant ones. In the plants infected with fungi or viruses there is typical decline in leaf area (Berghaus & Reisener, 1985; Magyarosy et al., 1976). This change may be partially (Berghaus & Reisener, 1985; Magyarosy et al., 1976 & Mitchell, 1979) or completely (Berghans & Reisener, 1985 & Wynn, 1963) accounted for by a reduction in chlorophyll content.

Photosynthesis is a basic function of green plants that enables them to transform light energy into chemical energy which they can utilize in their cell activities. Photosynthesis is the ultimate source of energy used in plant or animal cells. Since in a living cell, all activities expand the energy provided by photosynthesis, hence the rate of photo synthesis per plant as well as per unit leaf area got reduced under diseased condition. There was a gradual reduction in photosynthesis in diseased plants as compared to healthy plants at both the stages i.e. 35 days and 50 days after disease appearance. The rate of photosynthesis in healthy plants was 16.94 µmoles/cm^2/s at 35 days and 19.03 µmoles/cm^2/s at 50 days. Similarly, the rate of photosynthesis in diseased plants was 5.28 and 0.39 µmoles/cm^2/s at 35 days and 50 days after disease appearance respectively. The per cent reduction in photosynthesis was more after 50 days of disease appearance i.e. 97.95, while it was less at 35 days after disease appearance i.e. 68.83 per cent. The results of present studies are in agreement with studies of earlier workers (Allen, 1943; Livne 1964, Zelitch, 1982; Cooke, 1977, Kaur & Deshpande, 1980) who reported a decreased rate of photosynthesis in the leaves infected by rusts and powdery mildews. Black et al. (1968) also reported a decreased photosynthetic rate of cotyledons of *Raphanus sativus* following infection with *Albugo candida*. Similarly Garg &Mandhar (1975) observed that net rate of photosynthesis of infected pearl millet was reduced and it was 42% lower in infected plants than the healthy ones. The results of our findings also revealed a decreased rate of photosynthesis of infected barley leaves clearly due to large scale of destruction of chlorophyll in the infected plants.

Stomatal conductance indicated the level of pathogenicity and level of parasitic activities within the affected host cells. A desirable trait of disease defence mechanisms. The stomatal conductance was determined in healthy and diseased plants at two stages i.e. 35 days and 50 days after disease appearance. It is evident from the data in Table that stomatal conductance in healthy plants was more in 50 days than 35 days after disease appearance i.e. 1.64 and 1.42 µmoles/m^2/s. Stomatal conductance reduced in diseased plants maximum at 50 days i.e. 0.17 µmoles/m^2/s than in diseased plants of 35 days after disease appearance i.e. 0.40 µmoles/m^2/s. Similarly, the maximum reduction in stomatal conductance was found in 50 days after disease appearance i.e. 89.63 per cent. The reduction in stomatal conductance after 35 days of disease appearance was 71.83 per cent. Philip et al. (1991) also reported higher stomatal frequency in varieties of mulberry susceptible to leaf rust (*Cerotelium fici*). Similarly, Morton & Mathre (1980) also reported that the stomatal conductance is highly reduced due to the effect of *Cephalosporium gramineum* on winter wheat cultivars.

It is also evident from the data presnted in Table that rate of transpiration was more in healthy plants as compared to diseased plants at both the stages i.e. 35 days and 50 days after disease appearance. The decrease in transpiration rate was observed 35 days after disease appearance which was maximum after 50 days of disease appearance. The healthy plants at both the stages had higher transpiration rate i.e. 5.75 and 7.36 mmoles/cm^2/s as compared to 1.16 and 2.78 m moles/cm^2/s in diseased plants at both the stages i.e. 50 days and 35 days after disease appearance. Similarly, the per cent reduction in transpiration rate was more in 50 days after disease appearance i.e. 84.24 per cent than 35 days after disease appearance i.e. 51.65 per cent. The transpiration rate increased in healthy plants with the age of crop. Present findings are in agreement with Beniwal et al., (2008) who reported that the transpiration rate is greatly reduced in wheat plants infected with *U. agropyri*.

Table 1: Effect of Stripe Disease of Barley on Physiological Parameters

Parameter	35 days after disease appearance				50 days after disease appearance			
	Healthy plants	**Diseased plants**	**Reduction (%)**	**Two tailed t value**	**Healthy Plants**	**Diseased plants**	**Reduction (%)**	**Two tailed t value**
Chlorophyll*	26.45	7.92	70.25	172.4**	23.37	5.94	74.58	374.38**
Leaf area* (cm^2)	50.25	31.1	38.10	167.2**	60.2	31.5	47.67	633.877**
Photosynthesis* (µmoles/cm^2/s)	16.94	5.28	68.83	139.08**	19.03	0.39	97.95	3395.37**
Stomatal conductance* (µmoles/m^2/s)	1.42	0.40	71.83	39.193**	1.64	0.17	89.63	109.04**
Transpiration* (mmoles/m^2/s)	5.75	2.78	51.65	52.06**	7.36	1.16	84.24	677.26**

*Average of ten observation

**Significant at 5% level of significance

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