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Change in Respiration, Chemical Composition and Leaf Area of Wheat Plants Infected with Flag Smut

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ABSTRACT Respiration rate of inoculated seeds of highly susceptible and susceptible varieties increased around 6 per cent as compared to control whereas in resistant varieties respiration increased by around one per cent. At tillering stage more than 25 and 14 per cent increase in respiration was recorded in highly susceptible and susceptible varieties respectively, whereas less than one per cent increase was noticed in resistant varieties. Leaf area reduced significantly (i.e. more than 55 and 45 per cent) in highly susceptible and susceptible varieties and no reduction was noticed in resistant varieties. Maximum *in vitro* dry matter digestibility (IVDMD) was recorded in straw obtained from totally diseased plants as compared to healthy control. Ether extract, crude protein and crude fiber decreased in diseased plants.

Key Words : Flag Smut, Wheat, Respiration, *In vitro* Dry Matter Digestibility, Leaf Area

Wheat suffers from several diseases either in field or in storage. In India very little attention has been paid on flag smut caused by *Urocystis agropyri* (Preuss) Schroet. This disease is widely distributed in many parts of Haryana and causing considerable reduction in grain yield [1]. The localized incidence of flag smut in Haryana during 1987-88 ranged between traces to 50 per cent under natural field condition at Bhiwani, Ambala, Mohindergarh and Hisar districts [2]. As a result of the continuous cultivation of susceptible varieties in affected field there is a gradual increase of inoculum in the soil. Consequently, flag smut is assuming a serious threat to wheat cultivation. Therefore, the present investigation was carried out to ascertain the effect of disease on physiological parameters viz., respiration, leaf area and *in vitro* dry matter digestibility (IVDMD).

MATERIALS AND METHODS

Seeds of six wheat cultivars viz. WH 147, C 306 (highly susceptible), WH 542 and HD 2687 (susceptible) and HD 2329 and WH 896 (resistant) were inoculated with fine powder of flag smut of wheat @ 20g Kg-1 seed in a flask. Then respiration of inoculated seeds of all the three categories along with uninoculated control was measured. The oxygen uptake was measured by Gilson Differential Respirometer. After soaking seeds for 48h in moist rolled towel paper at 20°C, five seeds were placed in a reaction flask having 2ml of distilled water outside and 0.2ml KOH (10%) in side the control well. The temperature of the water bath of respirometer was set at 20°C. The reaction flasks were placed in the water bath and subjected to shaking at 78 ocillations^{min-1} for 30 min. and oxygen uptake was measured.

In another set, 10 days old wheat seedlings raised in pots from seeds of each variety were used. Two seedlings were placed in 2ml distilled water in a reaction flask and oxygen uptake was measured as in case of first set. Similarly, 60 days old diseased as well as healthy plants of each variety uprooted from field. One disease and one healthy tiller were placed in 2 ml distilled water in a reaction flask separately to estimate oxygen uptake. The experiments were replicated thrice.

The respiration rate was recorded as micro liters of oxygen absorbed per seed per hour (u/O_2/seeds /h) as well as micro liters of oxygen per gm per hour ($M/L/O_2/g/h$) at standard temperature and pressure:

$$\text{Respiration rate (RR)} = \frac{O_2 \text{ consumed}}{\text{Number of seedling}} \text{ X Time}$$

Ten diseased and ten healthy plants were tagged in each variety in the field. The total leaf area of all

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the leaves of plants i.e. from first to six, was measured by leaf area meter and the per cent loss in the leaf area of the diseased plants was calculated comparing with the leaf area of healthy plants. *In vitro* dry matter digestibility was determined by the method of Tilley and Terry [3].

RESULTS AND DISCUSSION

Seed respiration in highly susceptible cultivars WH 147 and C 306 increased slightly. The per cent increase ranged between 1.70-1.78 whereas in resistant cultivars WH 896 and HD 2329 it ranged between 0.73-0.86 per cent (Table 1). Similar results were obtained with 10 days old seedlings. Respiration rate of seedlings obtained from highly susceptible varieties, WH 147 and C 306 increased by 6.05 and 6.46 per cent respectively as compared to control. It was 83.53 u/L/O_2/h in WH 147 (Inoculated) as compared to 77.80 u/L/O_2/h in control. The increase was only 1.84 and 2.19 per cent in susceptible varieties WH 542 and HD 2687 respectively. Less than one per cent increase in respiration was recorded in resistant varieties. It was 0.79 u/L/O_2/h in WH 896 and 0.85 u/L/O_2/h in HD 2329 (Table 1). The respiration rate of diseased tillers (60 days old plants) also increased by 25.11 and 30.5 per cent in highly susceptible varieties WH 147 and C 306 respectively. In susceptible varieties WH 542 and HD 2687 the increase in respiration was 21.57 and 14.47 whereas in resistant varieties the respiration rate was not affected as per cent increase in these varieties was 0.39 and 0.37 per cent (Table 1). The results are in agreement with those of Kirely and Farkas [4] where they have reported that 35-40 per cent inhibition of respiration in rusted and mildew leaves of wheat. Somborski and Shaw [5], Grimm and Wheeler [6] also reported higher rate of respiration in rusted leaves.

Table 1. Effect of inoculum load on seed, 10 days old seedlings and 60 days old plants in different wheat varieties

Category/ Variety	Respiration rate u/L/O_2/h		Increase in respiration (%)
	Inoculated	Uninoculated	
Seed			
WH-147	117.66	115.55	1.70
C-306	108.66	106.88	1.78
WH-542	103.00	101.21	1.02
HD-2687	98.44	97.44	1.01
WH-896	121.77	120.88	0.73
HD-2329	99.33	98.44	0.86
C.D.(P=0.05)	1.77	0.69	
10 days old seedling			
WH-147	83.53	77.80	6.05
C-306	77.96	71.23	6.46
WH-542	66.03	64.23	1.84
HD-2687	51.23	48.93	2.19
WH-896	79.30	79.23	0.79
HD-2329	60.96	60.03	0.85
C.D.(P=0.05)	0.99	1.06	
60 days old plants			
WH-147	394.26	295.00	25.11
C-306	330.20	229.00	30.50
WH-542	361.60	283.60	21.57
HD-2687	373.20	318.80	14.47
WH-896	256.00	235.00	0.39
HD-2329	266.60	265.20	0.37
C.D.(P=0.05)	6.81	5.95	

Table 2. Effect of flag smut on leaf area in different wheat varieties

Variety	Leaf area (cm)*		Reduction in leaf area(%)
	Inoculated	Uninoculated	
WH 147	7.22	26.54	70.55
C 306	9.41	23.42	55.78
WH 542	12.30	23.42	46.95
HD2687	12.14	25.72	50.56
WH 896	28.77	28.93	0.55
HD 2329	25.61	25.75	0.54
CD (P=0.05)	0.59	1.66	

* = mean of sixty leaves (10 plants X 6 leaves of each plant)

Leaf area was reduced significantly in highly susceptible and susceptible varieties WH-147 and C-306, WH-542 and HD 2687 whereas it did not differ significantly in resistant varieties i.e. WH-896 and HD 2329. The leaf area of the diseased leaves of WH-147 was 7.22 cm as compared to 26.54 cm in control (Table 2). The per cent reduction in leaf area in diseased leaves of WH 147 was 70.55 followed by 55.78, 46.95, 50.56 in C 306, WH 542 and HD 2687, respectively whereas it was less than one per cent in WH 896 and HD 2329.

The total leaf area of diseased leaves of C 306, WH 542 and HD 2687 was 9.41, 12.30 and 12.14 cm as compared to 23.22, 23.42 and 25.72 cm in control, respectively. Whereas it was 28.77 and 25.61 cm in resistant varieties, WH 896 and HD 2329, respectively and it was not affected by inoculum because no diseased symptom appears in these varieties.

A decreased rate of photosynthesis in infected leaves with rusts and powdery mildews was earlier reported by Zelitch [7], Kaur and Deshpande [8]. Similar results were obtained by Gary and Mandhar [9], Bhatia and Thakur [10] and Kumar [11] where they found high reduction in net photosynthetic rate in downy mildew infected pearl millet leaves. Systemic infection of *Urocystis agropyri* in wheat WH 147 initially caused whitish patches or chlorotic area on the leaf surface.

Dry matter digestibility was maximum i.e. 48.03 per cent when straw was obtained from 100 per cent diseased plants followed by 46.82 and 44.51 per cent when diseased and healthy straw were used in ratio of 9 : 1 and 3 : 1 respectively, intermediate dry matter digestibility i.e. 26.03 per cent was observed when only healthy straw was used. Dry matter digestibility (Table 3) clearly showed that digestibility of wheat straw increased with the increase of disease. Arora *et al.* [12] found lignin and silica contents reduced. On the contrary, Luthra *et al.* [13] recorded the decrease in IVDMD (3-4 per cent) in downy mildew infected lucerne leaves. Similar results were also observed by Wilson *et al.* [14] that IVDMD decreased significantly in rusted pearl millet leaves. But in present study IVDMD of wheat straw increased with the increase of disease.

Crude protein of straw obtained from healthy plants was 3.84 as compared to 2.97 per cent of straw of diseased plants (Table 4). Similarly, ether extract was 2.25 per cent of healthy straw as compared to 1.64 per cent of straw obtained from diseased plants. Ash was also increased from 11.35 to 18.50 per cent, whereas, crude fiber decreased from 33.46 per cent to 14.17 per cent. Similar observation were recorded by Luthra *et al.*, [13] against downy mildew of lucerne. Quantitative and qualitative changes in proteins occur when a plant cell is penetrated by the pathogen and the origin of proteins is related to both plant and pathogen [15]. Bhatnagar and Kumar, [16] recorded severe decline in sugar content of clusterbean leaves upon infection of *Alternaria cyamopsidis.*

Table 3. *In vitro* dry matter digestibility (IVDMD) of diseased and healthy straw

Sr. No.	Ratio	IVDMD (%)
1.	90% healthy straw	
	10% diseased straw	28.83
2.	75% healthy straw	
	25% diseased straw	35.02
3.	50% healthy straw	
	50% diseased straw	40.30
4.	25% healthy straw	
	75% diseased straw	44.51
5.	10% healthy straw	
	90% diseased straw	46.82
6.	100% diseased straw	48.03
7.	100% healthy straw	26.03
C.D. (p=0.05)		0.74

Table 4. Chemical composition (%) of straw obtained from diseased and healthy plants on dry matter basis

Sr. No.	Composition	Healthy straw	Diseased straw
1.	Crude Protein	3.84	2.97
2.	Ether extract	2.25	1.64
3.	Ash	11.35	18.50
4.	Crude fiber	33.46	14.17

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